JAN 1 3 1933

The JANUARY, 1933

Heating · Piping and Air Conditioning

MODERNIZE!

Today a big proportion of the mechanical services in industry and large buildings are not in condition to meet operating and production demands as efficiently as desirable, as economically as possible . . . . In recent months, equipment obsolescence has been largely ignored, ordinary maintenance has been greatly neglected . . . This means waste, loss, inefficiency, inadequacy . . . . . Modernization means economy, profit, efficiency, preparedness . . . . It is good business, good engineering, good sense . . . . . .

MODERNIZATION NUMBER

TO KEEP UP . . . . . CHECK UP . . .

THRUSTOR Valves Solve Many Problems

A GENERAL ELECTRIC Thrustor valve solved the problem of automatic, accurate control of water for each batch of concrete according to weight—solved it to "our complete satisfaction" wrote the customer, and "this valve has functioned perfectly." A leather goods manufacturer writes: "The closing of the Thrustor valve, while being positive, is accomplished without sudden jar. We consider this unit to be a distinct improvement over former types of mechanical valve operation." Statements from users in a wide variety of industries attest the ability of Thrustor valves in solving difficult valving problems.

To keep up — check up your present valves. In this list—which is representative of scores of applications—check those about which you would like complete information:

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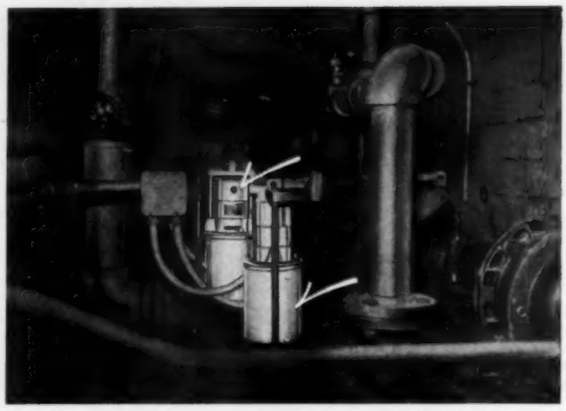
- ☐ Maintaining temperature in open tanks
- ☐ Maintaining water levels
- ☐ Introducing molasses or other heavy liquids
- ☐ Control of water flow (or other liquids)
- ☐ Controlling weight of materials
- ☐ Remote control
- ☐ .....
- ☐ .....



Two Thrustor valves doing a difficult job under an electric fountain

Line-up of Thrustor valves—a typical installation

Address your inquiry to the nearest G-E office, or General Electric Company, Schenectady, N. Y. Ask for a copy of publication GES-848, "Why Thrustor Valves?"

301-117

GENERAL ELECTRIC

Engin.

Heating · Piping and Air Conditioning

THE EDITOR'S PAGE

TO us, modernization means to replace where replacements are necessary, add where additions will improve, change where changes will benefit, repair where repairs will suffice—whatever will result in operating, producing and maintaining at the greatest efficiency and lowest cost that modern engineering and equipment make possible. We want to say—perhaps needlessly but to avoid giving any impression that we are trying to "sell an idea"—that there is no good reason for replacing, adding, changing or repairing unless it is necessary to achieving this condition of economy and efficiency. In this statement we mean either of two kinds of necessity—one, the obvious necessity caused by worn out, deteriorated equipment and facilities; two, the necessity, not always so obvious, caused by the fact that there are new methods and new equipment that can do the job better and cheaper than the present methods and equipment. Naturally the necessity is a matter of the individual situation's requirements.

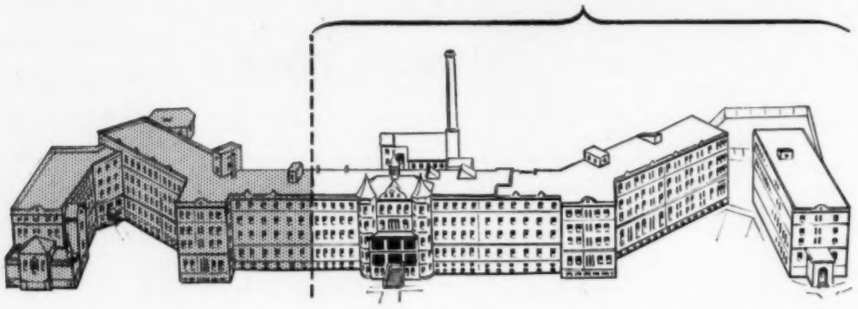
FOR a number of months we have felt that practical articles on where, why, and how to modernize heating, piping and air-conditioning systems have best fitted the current interests and needs of our readers, and have accordingly devoted large shares of our various issues to them. We expand, therefore, rather than depart from an editorial policy in devoting this entire issue to the subject of modernization.

WE present you in this issue, therefore, a line-up of facts on the proposition of modernizing heating, piping and air-conditioning systems in industrial plants and large buildings. We have obtained articles from leading authorities describing what such modernization has done for actual plants and buildings. The idea is that it might do the same for you. We have obtained information from many manufacturers on new equipment developments which have modernization applications. The idea is that they are ready for you to apply. All these we give you in the following pages, along with a few words we ourselves have to say on the subject.

THE theme is "Modernize—For Savings and Profit." Just as "there is gold in them thar mountains" there are savings and profit in modernization. The wise engineer will look for them.

33% MORE STEAM from the same amount of coal since Detroit Stokers were installed

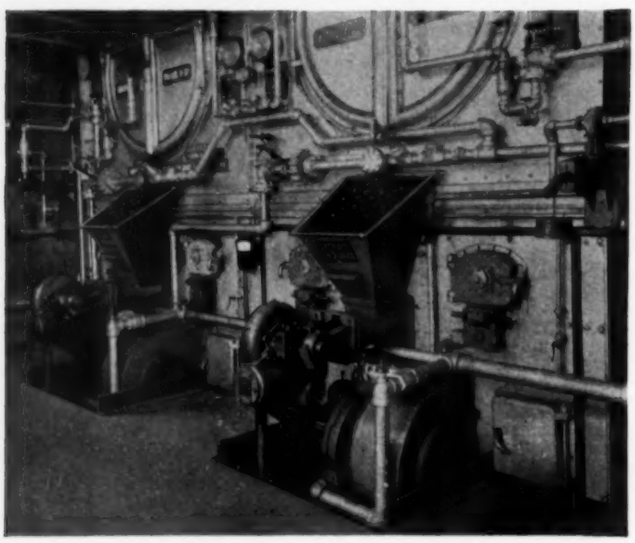
Heating original building required 2000 tons (average) per year before Detroit Stokers were installed.



St. Francis Hospital Evanston, Illinois

Wing added and Detroit Stokers installed. Heating requires only 2000 tons (average) per year.

This is the experience of the St. Francis Hospital at Evanston, Ill. When the north wing (shown in the sketch above by shaded area) was added in 1929, two Detroit UniStokers were installed. These are illustrated in the photograph below.



Two Detroit UniStokers (Turbine Driven)

Mr. Anton Young, Chief Engineer at the St. Francis Hospital reports that while the addition increased the heating load by about one-third, there has been no increase in coal consumption. The average annual coal requirement is now approximately 2000 tons . . . just as it was before the building addition and before the installation of Detroit Stokers. The new wing of the hospital is being heated for nothing.

This is typical of Detroit Stoker performance. Detroit Stokers quickly pay for themselves out of the savings they make. They also reduce the labor; boilers respond to changes in load with uniform steam pressure maintained. Objectionable smoke is eliminated.

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MODERNIZE AND ECONOMIZE WITH

DETROIT STOKERS

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Published Monthly by ENGINEERING PUBLICATIONS, INC. 1900 Prairie Avenue, Chicago

TERMS OF SUBSCRIPTION
Anywhere in the world, except Canada, $3.00 per year. In Canada, $4.00.
Current copies, 50c each. Back numbers, $1.00 each.
Member Audit Bureau of Circulations.
Member The Associated Business Papers, Inc.

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Address all Correspondence to Chicago Office.
New York Office, Room 1706-1707, 110 East 42nd Street.
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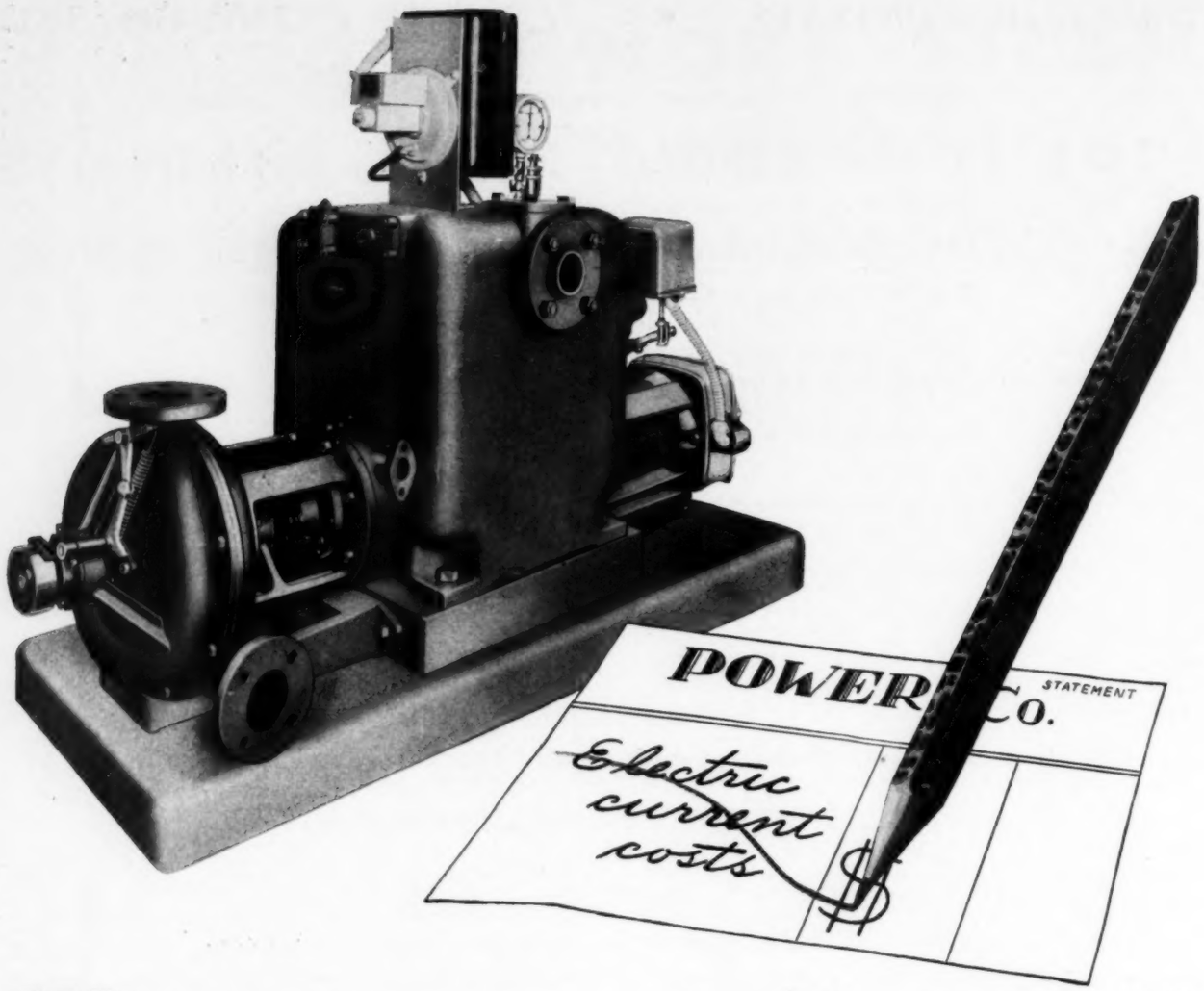


Why not cross out this expense?

Why not eliminate the one largest cost item in the operation of a return line heating pump, the electric current? The Jennings Vapor Turbine operates on steam directly from your heating mains, and returns that steam to the heating system with little heat loss.

This remarkable pump is driven by a newly developed vapor turbine which functions on a differential of only 5" of mercury, and on any type of vacuum heating system, regardless of type of steam control. It is equally efficient on low pressure steam, high pressure steam thru reducing valve, or on street steam. It makes no difference whether the system is run above or below atmosphere, because the turbine functions on the difference between the supply and the inlet, not on a given pressure above atmosphere.

But this saving in operating cost is not the only advantage offered by the new Vapor Turbine Jennings Heating Pump. This equipment gives you safety in your heating system. It is independent of possible current failures. It functions as long as there is steam in the heating system, assuring constant and reliable vacuum and boiler return.

Further, the fact that its operation is continuous means that the system is kept at the maximum of its operating efficiency at all times.

There are other points about this pump that it will pay you to investigate. They are covered in Bulletin 203. We need only your name and address to send you a copy.

THE NASH ENGINEERING COMPANY
SOUTH NORWALK, CONNECTICUT

The January, 1933

Vol. V, No. 1

Heating · Piping and Air Conditioning

Modernization . . . .

An Opportunity for Savings and Profit

THIS issue is devoted to the proposition of modernizing existing heating, piping and air-conditioning systems in plants and large buildings because today obsolete, worn-out and inadequate systems are being asked to "keep the show running" where improved, up-to-date systems would do the job not only better but cheaper.

A grave need today in business, industrial or commercial, is to hold costs in line with income. It is a natural impulse under the circumstances to try to make old things do. When, however, economy attempted through refraining from purchasing new and improved equipment results in increased operating costs, impaired production and decreased patronage—and these losses exceed not only a reasonable return on the investment required but in many cases the total investment itself—it is no longer economy.

Modernization is Good Engineering

In plant after plant, building after building today that is the situation. The curve of upkeep and maintenance is rising above the curve of income. Modernization offers the opportunity to reduce costs, make profits, improve competitive position on present business and provide for efficient operation and production when normal volume returns.

All of which presents the general case for modernization—sufficient, we believe, even in its generality, to warrant any plant or building engineer giving serious thought and careful investigation to the possibilities for savings and profits in modernizing the services in his charge.

At the same time, it is recognized that general cases are not always so enlightening or so convincing as specific cases, and unless definite, measurable proof of value can be produced to support them they present no practical solution to the problems for which they are advanced. Hence, this "Modernization Number"—to present to our readers what modernization of heating, piping and air-conditioning services in specific plants and buildings has done for them and how it has done it, together with an application and example review of the new and improved equipment which can be used in modernization projects. Thus, our readers may see what *others have done,* compare it with what *they may do* and inform themselves readily of the *equipment for doing it.*

There is no lack of evidence available. There are cases where modernization has cut operating costs. . . . Cases where modernization has changed production methods and resulted in a better product at a lower cost. . . . Cases where modernization has increased the number of customers, the volume of business and the profits.

In some such cases, it is true, modernization was undertaken because it could not be avoided—the existing system was worn out—only to discover after it was done that the modernized system with improved, up-to-date equipment showed substantial savings and would have been justified on that score alone, even though the old system had been able to function. In others modernization was carried through even though the existing equipment was holding together because it was shown that new equipment applied in the light of modern engineering practice made it good business to discard the old, take on the new.

Opportunities in Air Conditioning

The $30,000,000 worth of industrial air-conditioning equipment now installed in some two hundred industries is saving or making the plants that have it $15,000,000 yearly. This saving or profit pays off the original investment in two years; from then on it is clear gain. Yet, according to W. H. Carrier (who is the authority for these figures) only one-fourth of the plants that could be benefited by air conditioning have it. On this basis industry could invest an additional $90,000,000 in

air conditioning for production processes and make a further $45,000,000 per year on the investment.

Air conditioning for comfort has put theatres, restaurants, department stores and office buildings that have it far out in front of competitors without it. The public goes where it will be comfortable for its amusement, food and shopping. A restaurant installed an air-conditioning system and increased its summer business 60 per cent. A department store in the south installed air conditioning and, among other definite benefits it derived, showed a profit on its August business for the first time in twenty years.

Real Economies are Possible in Heating

In heating, a building originally equipped with a high-pressure plant in order to make its own electricity continued, after it changed to buying its power, to heat with the old high-pressure boilers. The cost of such heat was so great that the installation of two low-pressure heating boilers paid for itself in two years. Where changes in operating conditions have taken place, as in this case, real economies can be effected through modernizing.

Temperature control, properly applied, is saving twenty to forty per cent of former fuel costs. Stokers are paying for themselves in remarkably short time in more efficient firing, cheaper coal. Unit heaters are producing twenty to fifty per cent savings over antiquated pipe coils in factories. Research in heat transmission, developments in radiation and heat transfer equipment, refinements in heating systems are definitely showing opportunities for reducing heating costs in plants and buildings.

The Modernization of Industrial Piping Pays

As for piping, a study of processing can hardly fail to point out how piping can save handling costs. A chemical plant found that piping enabled it to buy its acids in tank-truck lots instead of in carboys. A candy plant found that piping enabled it to buy its milk and syrup in tank-car lots and distribute them to tanks, mixers and cookers with complete elimination of conveying and handling costs that would otherwise run high.

In the conveying of steam, water, air, oil, gas and refrigerants the opportunities for saving through modernizing are indicated in the saving one plant made of $11 per day through a simple change in its boiler blow-down piping, in a thirty-one per cent return on the investment in changing the suction line on a refrigerating compressor to the proper size, in a $300 annual return on an $800 investment in rearranging boiler leads, reducing sizes of the piping and welding the job.

So, as we say, there is no lack of specific evidence to support the case for modernization of heating, piping and air-conditioning systems. These are random examples which serve here merely to get the thinking well under way on the value of modernizing. The pages to come are full of such examples in complete detail.

If Modernization Pays, Modernize!

The next step, then, is to do something about it. If modernization pays, modernize! Equipment can be purchased and installed today at a cost below normal. Changes in equipment can be made most conveniently now when plants are not so busy. More new equipment has been developed in the last two years, with the primary idea of producing economies, than in any similar period in history.

Here is the opportunity for the engineer to fulfill the ultimate purpose for which he has his job—to run his plant or building, produce his goods, the most efficiently and economically that advanced engineering science and equipment developments make possible—and to do it when business most needs it. The front-office man can not be criticized for ordering expenditures curtailed. He does not know what replacements, changes or additions to his plant's heating, piping and air-conditioning services can save or make. He just knows that they cost money. At the same time, he knows the rule that money makes money, properly invested. It is the engineer's responsibility to show him this angle of modernization.

How to Plan for Modernization

We believe that this issue will give the engineer valuable information on which to build a modernization plan for his building or plant. With it he can check the heating, piping and air-conditioning systems employed in the operating and production services of his plant, get actual figures on the results accomplished in other plants through changes or additions similar to those his check indicates he can make, and then present, not a requisition for so much material or equipment, but a complete plan of what can be done, how much it will cost and how much it will save or make.

NEW YORK, Dec. 18.—Rehabilitation projects involving expenditure of $105,266,429 by industrial plants and retail establishments in the United States are under way or will begin shortly after the first of the year, according to A. W. Robertson, chairman of the national Committee on Industrial Rehabilitation. He recalled that this total compares with $70,875,000 in modernization commitments reported by his committee early last month.

Projects included in Chairman Robertson's report range all the way from maintenance and repair work in factories and stores up to actual construction of new buildings called for in industrial modernization plans. The projects reported are spread well over the country.

Industrial Piping Systems Pay Modernization Dividends

Opportunities for savings through piping modernization are shown in the experience of 10 different plants . . . . . .

By . . . . . A. W. Moulder*

Modernization of piping comes about through the fact that replacement is absolutely necessary or that rehabilitation will pay dividends. The author demonstrates by ten different examples of piping modernization opportunities in industrial piping systems to make savings:

1. In one plant changes in operating conditions have taken place in recent years. It rearranged steam mains, reduced pipe sizes and used welding to effect savings.
2. In another plant an old underground main was replaced by a new overhead steam main, eliminating waste due to local conditions.
3. In another plant, traps on ends of coils and at drip points were replaced, coils were regraded, a tilt trap was replaced with a condensation pump and receiver piping was installed. Savings in operating costs will pay for these improvements in two years.

These examples are typical of those to be found in this article. The engineer concerned with piping will find them of more than passing interest.

MODERNIZATION projects involving changes in piping systems are going forward in many industrial plants alert enough to look for ways and means of making savings—not only to meet today's conditions but to show continued returns year after year. A letter of inquiry to one organization specializing in industrial piping has brought to the writer's desk some extremely interesting examples of recently-made changes, large and small, which may be characterized as modernization or betterment.

In describing piping modernization projects it is difficult to divorce those which cover strictly and only piping from those in which piping merely plays a part or contributes to the success or economy of such undertakings, such as in the rehabilitation of a heating system. However, all of the following ten actual recent cases should be of more than passing interest to engineers concerned with piping or the economical operation and maintenance of industrial plants; they are all therefore quoted even at the risk of some of them appearing irrelevant to a discussion of modernization of piping.

Life of Piping Limited

The life of piping is limited by:

(1) Exterior corrosion
(2) Interior corrosion
(3) Wear and tear

Exterior corrosion is inexcusable in the case of all exposed piping. All piping, whether bare or insulated, should be kept pain'ed as necessary according to the conditions under which it is located to prevent exterior corrosion.

*Manager, Heating-Power and Industrial Piping Division, Grinnell Company, Providence, R. I.

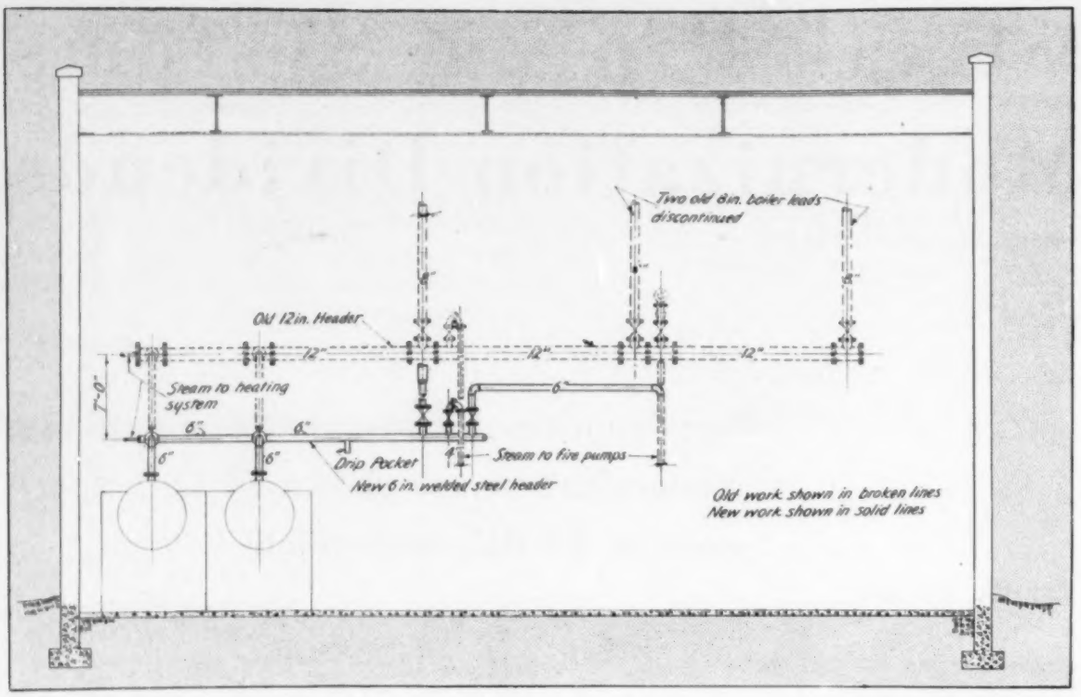


Fig. 1 (above) — In plants where changes in operating conditions have taken place real economies can be effected by modernizing piping; too often, old piping designed for the service of another day is left in just because it's big enough when modernized smaller piping would save money. On the job illustrated the new piping saves about $300 worth of steam per year; cost of the change was $800

Many Piping Materials Available

Interior corrosion is not so easily controllable but if the contributing factors are understood and analyzed for the particular service, then this form of deterioration may be kept at a minimum. Among these factors, of course, are—first and most important—the selection of proper materials for the service. Piping is available today in a variety of materials which makes it possible to insure practical permanence of installation to a degree which was unheard of a few years ago. A discussion of all of the kinds of piping materials available for various services would require many pages but suffice it to say that they are available in practically all of the base materials of commerce, such as copper, brass, aluminum, glass, wood, rubber, steel, wrought iron and cast iron as well as in many alloys. One interesting development which indicates the wide range of materials used is a pipe with asbestos base which is resistant to most acid fumes. It is light in weight and fittings. Suitable joints, etc., have been developed to a point where it is practical and economical to install.

It is essential that as replacements of piping become necessary due to deterioration this factor of interior corrosion be carefully studied to determine the materials which should be used for such replacement. Even though the material best suited may be more expensive in first cost it will usually be found to be cheapest in the long run.

Welding Has Place in Modernization

The method of joining many kinds of piping by welding should be considered. Welding of piping enjoys wide favor today; probably the greatest contributing factor to this is the availability of fittings especially adapted for welding. At the present time almost every conceivable type of fitting can be purchased whereby completely welded piping systems can be installed with the type of weld recognized as the simplest and strongest—the circumferential butt weld. With the use of such fittings the welder need only be qualified to make butt welds of full strength to be qualified for pressure pipe welding.

Proper Supports Will Save Trouble

A factor which probably contributes to both interior corrosion and also wear and tear of a piping system to a greater extent than is generally recognized is the proper supporting of piping when it is installed plus the need for thereafter keeping it in proper pitch and alignment.

Pockets or low spots in piping—not only with steam but with air and gases—will cause greatly increased corrosive activity at these points. These pockets are often caused by improper types of supports which allow the piping to sag or by not making provisions for adjustment to compensate for settling of the structure from which the piping is supported or hung. Item *2* of *Case No. 3* (following) suggests the possibility that if proper supports capable of easy adjustment had been installed originally these coils might not have required repairing and regrading.

Other causes of deterioration and wear and tear are inadequate provision for expansion and contraction or suitable hangers to allow for vibration; still another is the failure to provide for elimination of scale and for-

eign matter by installation of strainers at proper points to protect valuable apparatus, valves, traps, etc.

Recent Modernization of Piping Shows Possibilities

Modernization of piping comes about through the fact that replacement is absolutely necessary or that rehabilitation will pay dividends. The installation of a truly modernized piping system requires that real care and thought be given to the many factors which combine to make for efficiency of operation and long life.

The following cases indicate what opportunities exist in modernizing industrial piping systems. Obviously every piping service in industry could not be represented but the possibilities latent in this type of modernization are well demonstrated.

Old Large Piping Replaced

Case No. 1: This plant formerly produced its own power, but in recent years has electrified the machines and has been purchasing power.

The steam piping system was designed to supply large engines and was of large size; a large header acted as an accumulator.

By rearranging the boiler leads and reducing the sizes of the piping a considerable saving in fuel consumption has been made.

Welding elbows and nozzles were used throughout, resulting in a finished piping job which could be well insulated and contributing to fuel saving.

This case represents a most excellent example of what can economically be done in many plants. In plants where changes in operating conditions have taken place over a period of years, the real economies which might be effected by changes in piping are too often overlooked. Old piping which was designed for the service of another day is allowed to remain simply because it is "big enough" and the economies which might be effected by installing smaller modernized piping are rarely calculated.

Fig. 1 shows both the old and new piping systems. The saving in steam due to difference in heat loss between the two systems may be figured as follows:

Old Piping System

Amount of Piping Lineal Feet	Sq ft surface per lineal ft	Total Surface
58 ft of 12"	3.34	193.72
10 ft of 8"	2.26	22.60
48 ft of 6"	1.73	83.04
15 ft of 4"	1.18	17.70
		317.06

New Piping System

71 ft of 6"	1.73	122.83
13 ft of 8"	2.26	29.38
6 ft of 4"	1.18	7.08
		159.29

The following calculations for both the old and new piping systems are based on saturated steam at 150-lb gage pressure—365 F, and an average surrounding air temperature of 80 F. A *K* factor of 3 Btu per sq ft per degree difference between air and steam temperature is used.

In the case of the old system, assume that because of the number of fittings and flanges in the lines the insulation had an overall efficiency of 75 per cent. With the new system (on account of the welded piping and therefore a continuity of insulation not otherwise practical to obtain) assume an overall insulation efficiency of 85 per cent.

The results of the two calculations are as follows:

Old System

Sq ft Total Surface	× *K* Factor	× Deg Diff Steam Air (365-80)	× Hr per Day	× Efficiency of Insulation (100%—75%)	= Btu's per day Loss
317	× 3	× 285	× 24	× 0.25	= 1,626,210

New System

159	× 3	× 285	× 24	× 0.15	= 489,402
				Difference	= 1,136,808

Assuming 350 working days per year, reducing the difference to pounds of steam and figuring $0.70 value per 1,000 lb of steam, the saving per year would be represented as follows:

$$\frac{1{,}136{,}808 \text{ Btu's per day} \times 350 \text{ days}}{960 \text{ Btu's} \times 1000 \text{ lb steam}} = 414 \text{ M lb steam}$$

× $0.70 per M steam = $289.80 per year, approximately

The value of the investment necessary to make the changes to bring about this saving, including insulation, amounts to less than $800.00. This return on an investment may seem somewhat unusual but there are undoubtedly many other cases where conditions have brought about changes and where handsome returns can be realized by eliminating hot "dead" piping or by replacing large, old piping transmitting heat or "cold" with piping figured to proper sizes by modern methods and installed and insulated in accordance with modern practice.

New Overhead Main Installed

Case No. 2: At this plant a new overhead steam main was installed from Mill No. 1 to Mill No. 2. The new main replaces a present underground main which had been installed in conduit years ago. In wet weather the old underground conduit leaked so badly that the steam in the underground line was condensed to such an extent that it was impossible to provide the necessary steam to Mill No. 2.

This example suggests a condition which exists in connection with many older steam piping systems and which will bear investigation. It is not intended to indicate that hot piping may not be efficiently installed underground in properly-drained modern conduit, trenches or tunnels, but to suggest that the efficiency of existing old underground hot piping installations may well be checked with a view to inquiring whether or not replacement or modernization will pay.

"In every period of depression in the past when business has been resumed there has been a lot of old equipment discarded and replaced with new equipment. The underlying idea, of course, is that new equipment is more efficient, and immediately following any depression every attention is given to keeping costs at the lowest possible point."— ***W. A. Hanley, Director of Engineering, Eli Lilly and Company.***

It developed in connection with this job (due to local conditions) that the most practical and efficient method of correcting the faulty and wasteful condition which existed was to install new overhead piping. Figs. 2 and 3 show how this piping was installed.

The fact that adequate steam can now be delivered to Mill No. 2, whereas previously this could not always be done, is not only evidence of the necessity for this change but indicates quite clearly that substantial savings are being effected.

Several Deteriorated Systems Replaced

Case No. 3: Considerable piping work has been done at this plant during the past few months, as follows:

(1) Replaced all traps on ends of coils and at drip points.

(2) Repaired or replaced all deteriorated pipe in coils and regraded all coils.

(3) Replaced old one-pipe gravity heating system in office with a new two-pipe system.

(4) Replaced tilt trap draining dry cans with a condensate pump and receiver.

(5) Insulated all slasher piping and size piping and size kettles.

(6) Replaced old terra-cotta pipe line from dam to reservoir with cast-iron pipe.

All of the above replacements and additions were made for the sake of economy in maintenance and operation. It is expected that the savings will pay for the improvements in about two years' time.

This job stresses a very important phase of modernization—replacement made necessary due to wear, tear and deterioration. Most of the items listed in this case come under the class of replacements of worn out piping materials and yet it is expected that by replacing these with materials better suited in the light of more modern engineering knowledge or practice, the saving will pay for these improvements in the short time of two years.

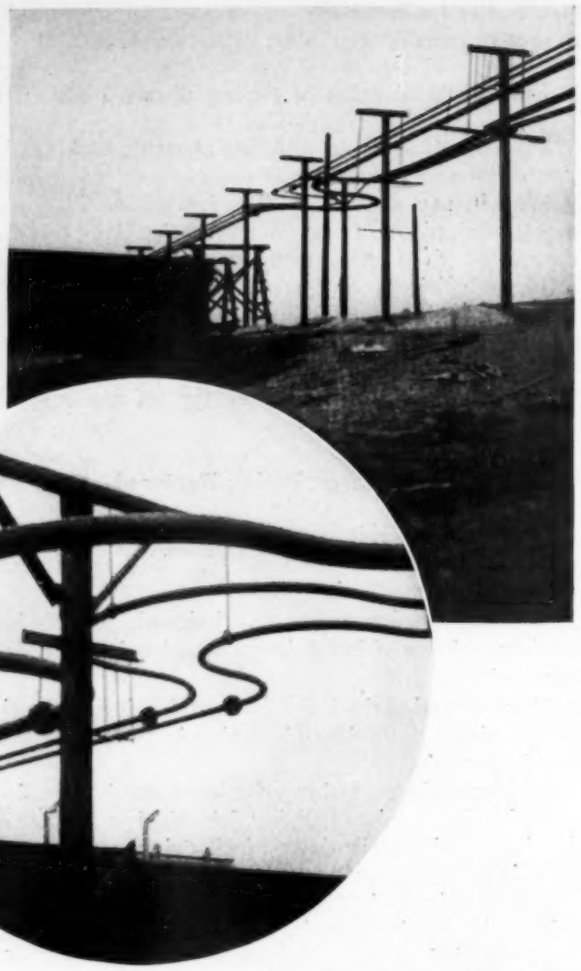
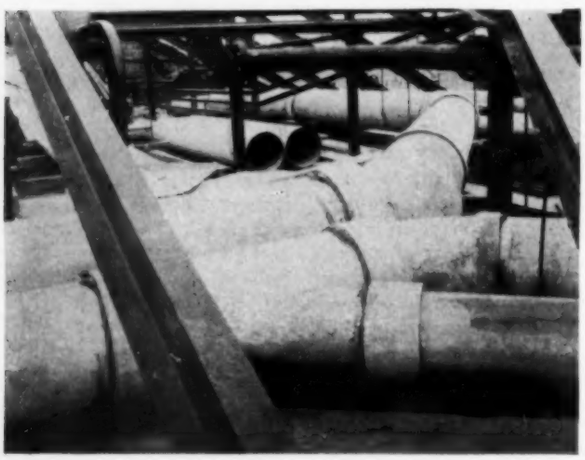


Fig. 2 (top)—New overhead steam line before insulation was installed. Because of local conditions, it was found advisable to replace an old underground line with this new overhead line

Fig. 3 (in circle)—Close-up of expansion bends in new overhead line at a mill

Fig. 4 (below)—Piping is available today in a wide variety of materials to suit varying requirements. Indicative of the range of materials employed in fabricating piping is piping made with an asbestos base, resistant to most acid fumes. The piping shown here collects fumes from a laboratory



Process Hot Water Supplied Economically

Case No. 4: This concern had a small dye plant that required a large amount of hot water and the peak load required 150 hp for which a new boiler was required. This condition was taken care of economically by installing a hot-water storage tank and a 60-hp boiler—and the necessary piping—so that the load could be handled as an average load instead of as a peak load.

Process and Heating Condensate Returned to Boilers

Case No. 5: Heating system remodeled; open-type feedwater heater installed and piping arrangements made to return all condensation both from heating and process equipment to the boilers through the feedwater heater.

This change-over effects considerable saving as the temperature of the feed water going to the boiler was raised from 80 or 90 to approximately 190 degrees.

Saves Thousands on Fuel

Case No. 6: This plant is a large manufacturer of wooden boxes and crates; the waste lumber, sawdust and shavings accumulate faster than they can be sold, given away or burned.

This company decided to install boilers and an engine generator for making all of the electricity needed for the plant with the idea of using the waste lumber, shavings, etc., as the only fuel.

Engineers were called in to design a complete power plant and the necessary piping.

Thousands of dollars are being saved annually on account of the fuel costing practically nothing.

Pipes Spring Water for Air Conditioning

Case No. 7: This company was purchasing a large quantity of water for use in air conditioning when it was discovered that they had a clear water spring of ample capacity for their needs on their premises. Arrangements were made to pipe this water to an old water tank located in the tower of the mill which is kept full by a centrifugal pump located at the spring with remote electrical automatic control.

Replaces Depreciated Units

Case No. 8: This job consisted of furnishing and installing two water-tube boilers, the proper piping and the necessary auxiliary equipment, such as boiler-feed pumps, automatic water regulators, governors, etc.

These units replaced present equipment, which had depreciated to such an extent that the repairs and maintenance were very excessive.

At the same time these new boilers were designed with extra large firing doors so that wood refuse from the factory can be burned advantageously.

Old Pipe Coils Taken Out

Case No. 9: This plant is a large manufacturer of hosiery.

Overhead-type unit heaters were installed to replace the old pipe coils in the entire plant. Thermostatic controls were provided for all heaters. New vacuum pumps were installed for all heating systems and the condensate from all steam-using equipment was returned to a new feedwater heater.

The installation of the unit heaters, thermostatic controls, vacuum pumps and feedwater heater made it unnecessary to add additional boiler capacity to take care of a new addition to the plant, as was at first contemplated.

Unit Heaters Replace Pipe Coils

Case No. 10: This job consisted of furnishing and installing unit heaters and the removing of the old overhead pipe coils. The old heating system consisted of three branch pipe coils of 3-in. pipe size of the return-bend type. The building was originally designed for a cotton mill and was operated as such for a considerable length of time. When, however, the building was taken over by a tobacco concern and the shafting, belts, etc., removed, it was found that the pipe coils were not satisfactory, due to the fact that the heat banked up at the ceilings. This unit heater job has been entirely satisfactory and the steam consumption greatly reduced by the use of these overhead-type unit heaters which direct the heated air downward and also due to the thermostatic controls which are installed in conjunction with the unit heaters.

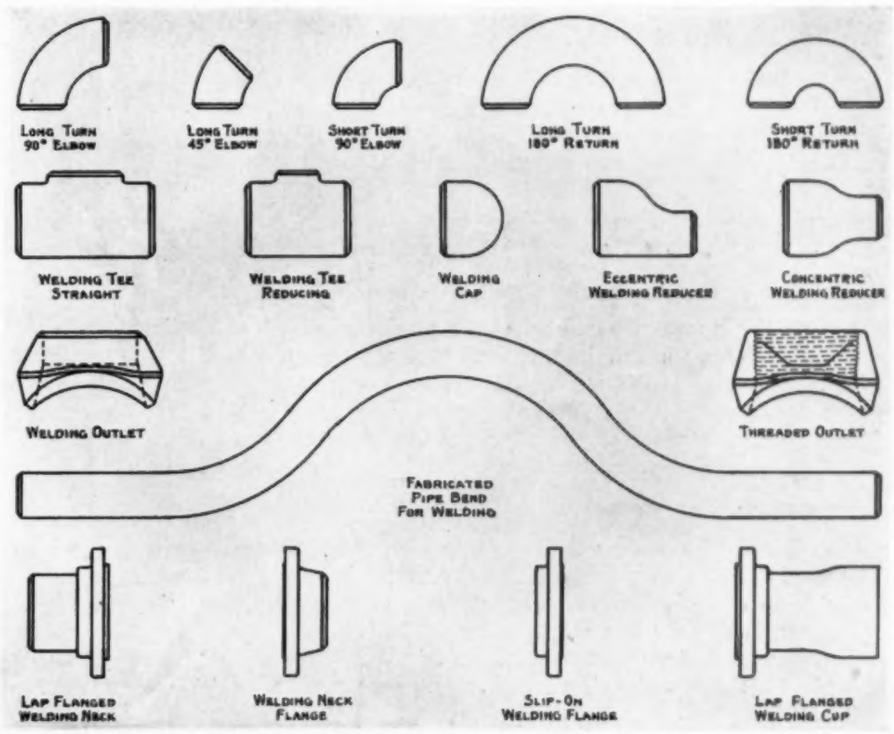
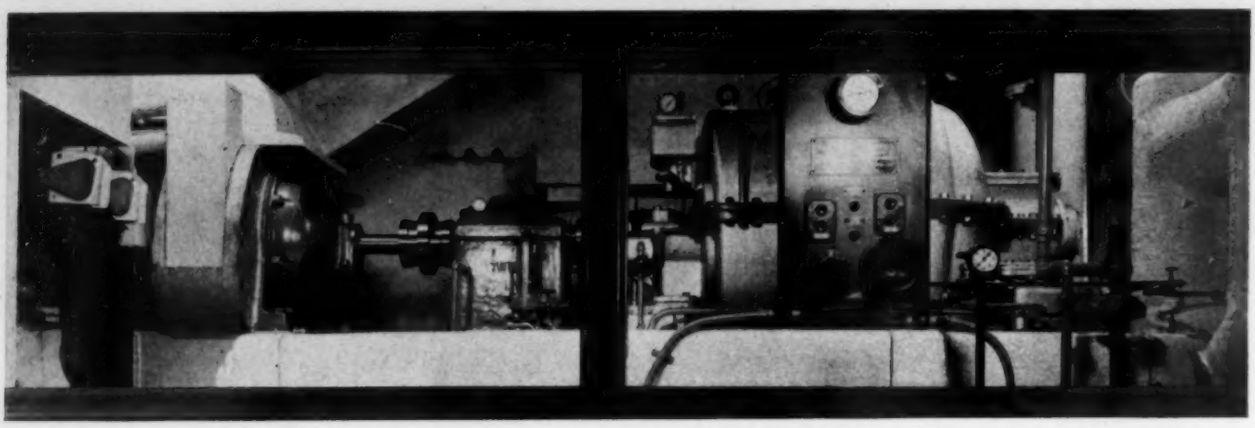


Fig. 5—At the present time almost every conceivable type of welding fitting is available; these fittings are largely responsible for the favor welding enjoys



Modernizes and

Profits With Air Conditioning

REALIZING the advantages of prevailing costs of materials and labor, and moved by the impulse to assist in the general effort to create profitable employment, F. W. Evans, President and Manager of D. H. Holmes Co., New Orleans, La., the South's largest department store, proposed to his Board of Directors that an air-conditioning system be installed. The Board, desiring to keep in step with modern development despite the present depression voted to undertake the enterprise; the author was called in to make a careful engineering analysis of the situation and proceed with the installation.

Results Prove Investment Wise

Approximately 123,000 sq ft of floor area, (1,225,000 cu ft) was conditioned at a cost of 8½c per sq ft. The average sale of the store is from $2.00 to $2.50, giving a cost for air conditioning of approximately 1c per sale, or less than 0.4 of 1 per cent of the gross sales.

The results demonstrate forcefully the business acumen of the management in authorizing this investment for modernization of its building; they also indicate how powerful is the effect of air conditioning on the success of an enterprise depending on the patronage of the public, such as stores, office buildings, hotels, restaurants, railroads, theaters, banks, etc.

Profit Replaces August Loss

August has always been a bad business month in the past, due to excessive street temperatures. However, for August, 1932, (the first August after the installation of the air-conditioning plant) a net profit is shown on the books for the first time in twenty years. Less spoilage of merchandise from try-ons by customers occurred during the past summer's operations than for any other year in the history of the store; this is due to air conditioning.

It is recognized by the management, though not susceptible of proof, that its volume of customers has increased since the installation of the air-conditioning plant.

450 Motor Hp Installed; Power Cost Lower

Through a general power rate reduction effective March 1, 1932, and a promotional rate made effective shortly thereafter, plus elimination of all ceiling and bracket fan equipment, considerable reduction in the total electrical energy charges was effected:

Electrical energy charges		1930	1931	1932
Entire establishment	June	$2,596.01	$2,724.85	$2,522.50
"	July	2,592.99	2,703.56	2,626.19

When it is considered that the amounts for 1932 carry $37.28 for June and $76.49 for July to cover the new Federal tax, it is apparent that, even with the installation of some 450 hp of motor equipment, the total electrical energy cost for power and light for the months indicated shows a decidedly worthwhile net saving.

Customers See Equipment Through Glass Walls

The project offered some interesting problems, not the least being that of making the installation without interruption to business. It was decided to install the refrigeration plant behind glass walls in the center of the store for advertising purposes. Careful plans and an installation schedule had to be worked out as the areas which were to be conditioned sometimes handle 52,000 customers during a normal eight-hour day.

*Consulting Engineer, New Orleans, La.

Left—Looking through the window at the air-conditioning equipment. In the center of the store, visible through glass walls, this equipment advertises that the D. H. Holmes store is modern. The glass through which the photo was taken is triple-thickness, each pane of different thickness with a varying air space between each to prevent possibility of noise transfer. A turbo-blower exhausting from the housing over the main motor removes heat from the machinery room; cooled air is also introduced

▼ ▼ ▼

By James M. Todd*

How modernization PAYS NOW is told in this article describing the air-conditioning system installed in the D. H. Holmes Co. department store in New Orleans. In addition to realizing the advantages of prevailing labor and material costs, creating profitable employment, keeping in step with modern development, the management's business judgment was proved wise by the following results:

1. The cost for air conditioning was less than 0.4 of 1% of the gross sales.

2. The books of the store show a net profit for August, 1932; the first August in twenty years that this "bad business month" has not shown a loss.

3. Spoilage of merchandise from try-ons lowest last summer than any time in the store's history.

4. The volume of customers has increased.

5. By a general reduction in the cost of electricity, an air-conditioning promotional rate, and the removal of ceiling and bracket fan equipment, a worthwhile net saving in the cost of electricity was effected.

Sales Spaces, Restaurants, Offices, Beauty Parlors Conditioned

Only two floors of the general sales spaces are conditioned, as a careful survey showed that 50 per cent of the store's business is done on the first floor and 30 per cent on the second, the balance being spread approximately equally between the other floors. The installation is divided into five parts: The main sales spaces and beauty parlors on the first and second floors; the general restaurant on the first; the administrative offices on the third, and the employe's cafeteria on the fourth.

All these departments offered no special problems with the exception of the restaurant. There, the operating hours do not quite fit in with the operating schedules of the other departments, so arrangements are made to provide refrigeration for this area when the main plant is shut down. This is accomplished by the excess storage capacity in the main air-washer tank and by running the water temperatures to a fairly low level just before shut down of the refrigerating equipment.

Machinery Room Is Sound-Isolated

It was necessary to insure against the air-conditioning equipment causing any objectionable noises in the sales areas. Space for the installation was limited because all space on the first floor is considered quite valuable; the weight of the equipment made it impractical, at reasonable cost, to install it at any other than ground level. It was necessary to accomplish a 75-decibel reduction in noise level; investigation showed it physically impossible to absorb sufficient noise in the materials it was possible to get into the areas involved to accomplish this result. Accordingly, the machinery room was sound-isolated from the balance of the store.

This isolation was done with a 1-in. thick expansion joint separating all machinery foundations from the floor of the machinery room. The floor of this room is also segregated from the walls by another 1-in. expansion joint completely around the room. The walls and ceiling of the room were lined with 1-in. hair felt, followed, in the case of the walls, by a 3-in. air space, metal lath and plaster; and in the case of the ceiling, by a 6-in. air space and 2½-in. thick acoustic tile.

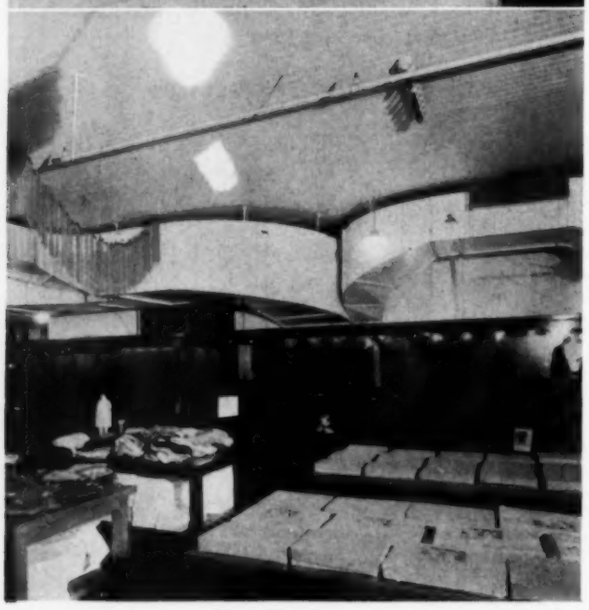
Plant Has 242-Ton Capacity

Due to excessive humidity conditions at certain seasons of the year in New Orleans, design of the system was based on 85-F dry bulb and 45 per cent relative humidity inside, with 95-F dry bulb and 80-F wet bulb outside. The following arbitrary heat loads were set:

1st	Floor	Sales	800	people	77,500 watts
"	"	Restaurant	250	people	7,800 watts
2nd	Floor	Sales	600	people	62,000 watts
"	"	Beauty Parlor	65	people	54,500 watts
3rd	Floor	Offices	70	people	13,800 watts
4th	Floor	Cafeteria	175	people	3,200 watts

The operating guarantees were based on these conditions, all of which were established after a careful check and survey extending over a period of six months. Requirements were based on 25 per cent outside air, and 75 per cent conditioned air to all departments.

The 242-ton capacity main refrigerating plant consists of a centrifugal refrigerating compressor, driven



Top—Distributing ducts on the second floor before the ceiling fan equipment was removed. Because of the sprinkler piping, lighting equipment, beams, columns, etc., difficulty in keeping the ducts near the ceiling was experienced

Center—Barber-shop section of the beauty parlor, illustrating the punkah louvers to adjust air delivery to suit the individual customer. At the extreme right the outlet is "full closed"; the others are at varying angles of air delivery. The ducts are laid on top of the half-partitions for appearance

Bottom—Main conditioned air ducts on the first floor; they were run as high as possible. The adjustable outlet used throughout the entire sales space is seen on the duct outlet to the right; by adjustment of a screw on the outlet face, an inside damper closes or opens the outlet throat to vary the air delivered

by a 300-hp, 208-volt; 3-phase, 60-cycle, variable-speed motor running at 1,750 rpm; connection is made through a step-up gear to the compressor, which runs at approximately 3,800 rpm, using carrene (CH_2CL_2) as the refrigerant. The complete refrigerating plant, including cooler, condenser, compressor, driving motor and control, with liquor pump, and hoist and trolley for dismantling, is installed in a room 15 ft wide, 22 ft long, and 14 ft high. To ventilate this room and absorb the heat from the compressor and motor grids, a supply of three 6 in. by 6 in. openings from the main conditioned air duct is provided, and a 900-rpm turbo-blower exhausting to the street takes its suction from a metal housing constructed over the main motor unit.

The cooling tower was placed on the roof of a warehouse building owned by the store in an adjacent block; the supply and return piping runs to the fourth floor of the store building, thence through a connecting bridge between the two buildings to the tower. It was necessary to install the tower this way to get proper ventilation to insure its correct operation and because the store structure would not support the weights involved.

The main condenser water pump unit handles 1,000 gpm against a total dynamic head of 120 ft; it is direct connected to a 50-hp, 1,750 rpm, 208-volt, 3-phase, 60-cycle, constant-speed induction motor. It is installed in a small room at the bottom of the fresh-air shaft. In this same space, a 4-in. pump of the same type, designed for 875 gpm against a 100-ft head (and driven by a 40-hp motor unit) supplies the spray heads in the main air-washer unit for Apparatus No. 1.

Apparatus No. 1, for handling the main sales spaces, was installed on the second floor directly above the main refrigerating plant. Glass panelled doors expose it to public view. This apparatus consists of a washer or dehumidifier with an extra large water tank to act as carry-over capacity for the restaurant apparatus. The duplex conoidal fan serving the main store areas is driven through multiple V-belts by a 40-hp, 208-volt, 3-phase, 60-cycle, constant-speed motor. It has a 117,000-cfm capacity, which gives an air change every ten minutes in the sales space conditioned.

Automatic control of the store area is obtained with air-motor equipment operating fresh air dampers, and recirculated air dampers to the dehumidifier and bypassing the washer. These air motors are served by a small air-compressor unit installed in the conditioned air intake of the main fan unit to insure clean air to the control equipment.

Taking washed air supply from the main dehumidifier, the restaurant Apparatus No. 2 takes its recirculated air from its own spaces. It consists of a centrifugal fan

driven through a multiple V-belt rope drive by a 5-hp, 208-volt, 3-phase, 60-cycle, 1,750-rpm constant speed motor.

Air to Booths Individually Controlled

Of particular interest in this installation is the application of the patented "punkah" louver to the beauty treatment booth. One of the illustrations shows this louver, and how it is adjustable, by hand, to supply air at any angle, and at any volume from full open to shut-off. Two such louvers are installed in each booth.

Apparatus No. 4 and No. 5, for supplying the cafeteria and the administrative office, take cold water supply from the main dehumidifier pump through a cork insulated line. This group consists of a double pass dehumidifier unit maintaining level in its own tank by means of a float-valve and weir. The spray heads are served by a 2-in. double-suction pump unit, delivering 127 gpm against a 70-ft head, driven by a 5-hp, 208-volt, 3-phase, 60-cycle, 1,750 rpm constant-speed, direct-connected motor.

For the cafeteria a centrifugal fan unit driven by a 3 hp, 208-volt, 3-phase, 60-cycle, 1,750 rpm motor through V-belts, with individual fresh air, recirculating, and mixing dampers, air-motor controlled, takes supply from the left, or smaller portion of the divided dehumidifier. In a similar manner, with individual damper controls, a fan unit driven by a 5-hp motor supplies the administrative offices.

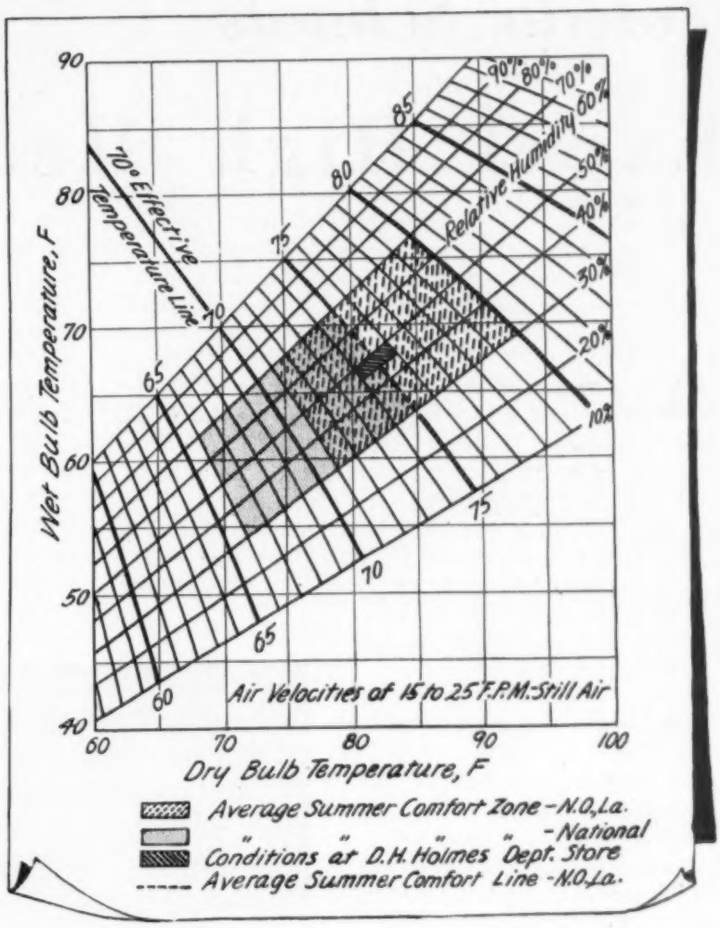


Chart showing comfort conditions which best apply to New Orleans' (or similar) climate. A survey made by D. H. Holmes Co. indicated that 77 per cent of the customers thought the air in the store was "just right"

Comfort Zone in Southern Climate

It is interesting that the conditions for which this system was designed vary considerably from the usual. Due consideration had to be given the climatic conditions to which people in New Orleans are accustomed and to their clothing, which is very light with little or no heat insulating properties. Past experience with theater jobs verifies the conclusion that people in hot climates cannot comfortably endure temperature differentials in excess of 10 F. This is especially true of patrons of a department store, who are in conditioned areas but a short time. Designing for larger temperature differentials in such a climate only results in excessive initial and operating costs.

The air conditioning promotional division of the New Orleans Public Service company, realizing that the comfort zone as shown on the average psychrometric chart did not apply locally, and, if used, would result in discomfort, made an intensive study of local weather conditions of the past ten years, and gathered all available data on tests and experiences locally in connection with air conditioning for human comfort. These data were used in establishing a comfort zone which best applies to New Orleans, or any locality with similar climatic conditions. Unidentified post cards were sent by D. H. Holmes Co. to 15,000 patrons and friends of the establishment, asking for frank criticism or comments. 2,716 answers were received, of which,

2,004	(77%)	felt conditions were just right.
671	(21%)	felt conditions were too cold.
41	(2%)	felt conditions were too hot.

In a climate such as that in the New Orleans district, in fact in almost any southern district, the author believes the problem of air conditioning to be more important than that of heating. It is safe to predict that in the not-very-distant future, any establishment catering to a critical clientele will find it not only expedient to consider air conditioning, but an absolute necessity to provide it in one form or another. It is my opinion that air conditioning will show an even greater development in the next ten years than has been experienced in the past decade.

In conclusion, I wish to express my indebtedness to G. E. Mays and P. Hoots of the air-conditioning promotional division of the New Orleans Public Service Co. for the data and chart showing the study of comfort conditions in the New Orleans area.

Toledo Schools

Expel High Heating Costs

By Samuel R. Lewis*

AN interesting testimonial to skillful operating engineers is exemplified in the fuel costs for the Woodward senior high school in Toledo, which went into service in 1929. It is equipped with four 78-in. by 18-ft, 10-in. firebox boilers operated at about 45-lb pressure, which have down draft furnaces built into them. Heating of the building is accomplished very largely with indirect heaters located in walkway tunnels and at the bases of the air supply flues, so that gravity operation is feasible. Main supply fans and pumps are steam-engine driven.

1st Season, 95.1c per 1000 Cu Ft

For the season of 1930-31 the operation of the whole school was being coordinated and much lost motion and experimentation doubtless was encountered before that perfect understanding could be reached between the educational and the mechanical staffs which resulted in any department such as class rooms, laboratories, gymnasiums, auditorium, cafeteria, etc., being ready when wanted, but never being unnecessarily heated and ventilated. The building is zoned, with several separate air-supply systems, facilitating economical operation.

Fuel report for 1930-31. 1,025 tons Ohio mine-run coal at $3.89, $3987.25.

Contents of building, 4,190,200 cu ft.

Cost of coal per 1,000 cu ft 1930-31, 95.1c.

2nd Season, 77.5c per 1000 Cu Ft

Profiting by the experiences of this first winter, when the second heating season came around coordination between services had improved and advantage was taken by the engineering staff of the occupancy schedules. More skillful firing had been learned. Coal was purchased by the Board of Education at 40 cents less per ton than the price of the year before, and the winter of 1931-32 was milder than that of the preceding year. Result:

Fuel report for 1931-32. 760 tons at $3.49, $2,652.40. This divided by 4,190,200 cu ft gives cost of fuel per 1931-32 season per 1,000 cu ft, 63.3c

Suppose we admit that 1931-32 required 10 per cent less coal than 1930-31 because of milder weather, and suppose we pay the 1930-31 price for coal. Then for 1931-32 the figures would be: 760 plus 76 = 836 tons at $3.89 = $3,252.04 ÷ 4,190 M = 77.5c per 1,000 cu ft.

Here's an article written in Mr. Lewis' distinctive style on the cost of fuel for heating school buildings; it's one that the engineer concerned with heating any type of building can read and heed with pleasure and profit.

Among the points brought out in this article are:

1. Skill in operation is an important factor in cutting cost; at the Woodward school, Toledo, it reduced the cost of fuel (in cost per 1,000 cu ft of space heated per season) from 95.1 to 77.5 cents.
2. Automatic coal handling and combustion control should be considered in modernizing heating plants.
3. Stokers may prove the answer to providing increased heating plant capacity; at the Cherry school, they cut the fuel cost 75c per 1,000 cu ft per season and saved a heavy capital expenditure.

A tabulation comparing the cost of fuel for heating various types of schools in a number of cities is included. In it are some valuable sidelights.

Result of Operating Skill

The difference between 77.5 and 95.1 cents per 1,000 cu ft of space heated and ventilated per season, 17.6 cents, illustrates one aspect of the value of the factor of skill and care and experience in handling the heating and ventilating apparatus in a large building.

1st Year with a Stoker Plant

The DeVilbiss senior high school, Toledo, was completed in 1931. It is equipped with four 72-in. by 18-ft, 0-in. horizontal return-tubular boilers, operated at about 120-lb pressure, which have forced-draft under-feed stokers and automatic combustion control. The boilers are in a detached building, so that the heat escape from them serves no useful purpose, compared to the situation at the Woodward school where the boiler-room waste heat warms the floor and walls of the rooms above it.

The 1931-32 fuel report for the DeVilbiss school is:

1,065 tons Ohio screenings at $3.19, $3,397.35. This divided by 5,042,000 cu ft, the contents of the building, gives cost of fuel per season per 1,000 cu ft heated, 67.4c.

*Consulting Engineer, Chicago, Ill.

The heating and ventilating system, aside from the differences in the boiler room and stokers, carries out the same ideas of zoning and diversified remote control and absence of direct radiators from classrooms which distinguish the Woodward plant. There is no reason to believe but that 1932-33 will witness a proportionate reduction due to the experience-skill factor in the DeVilbiss cost. The presence of the super-human automatic combustion control at the DeVilbiss school may, of course, even during its first winter, have discounted this possible saving.

One might conclude, hastily, that the evidence of comparison between the fuel costs of the two latest Toledo high schools was not favorable to automatic stokers. Such a conclusion from these figures is not justifiable. At Woodward, for instance, each shift requires two firemen, while at DeVilbiss one man per shift easily can perform the entire coal handling. At Woodward the coal has to be wheeled from the bunkers and spotted very accurately to cover the grates. Clinker removal requires expert observation and skilled labor.

At DeVilbiss, all coal handling (after the comparatively slight use of a wheel scoop to bring the coal to the under-floor hopper of an electric conveyor in the bunker) is mechanical. Clinkering is a very much easier task than at Woodward, since side-dump stokers are provided.

We await, however, the comparative results of the coming season with great interest for these two buildings, so similar in every way except in their boiler rooms.

Addition Made to Old School

Stokers have their place and can show in Toledo very substantial savings as the Cherry-Feilbach experience proves.

The Cherry school was built way back in 1914. It had two 66-in. by 16-ft, 0-in. horizontal tubular boilers of the best type of construction, with high settings and with hand-fired grates provided with special high-temperature smoke-consuming arches and steam jet draft inducers recommended at that time by the Chicago smoke prevention department. This scheme was not satisfactory as a smoke consumer, and for years Pocahontas coal has been burned in the Cherry school as a matter of smoke abatement. The boilers were somewhat over-size, beyond normal rating, to allow for a possible future addition. In 1930 this addition finally was made, but it became the Feilbach school, a separate building on the same plot, requiring nearly as much steam as did the Cherry school.

Stokers Increase Boiler Capacity

The boiler problem was met by installing modern forced-draft underfeed stokers under the old boilers in the Cherry school, and by proportioning these stokers for developing up to 145 per cent of the boiler rating. The whole situation is one which especially is favorable to such a project and the results prove ample justification and point to the stokers as an excellent investment.

Fuel report 1930-31, old building only, 270 tons semi-anthracite at $4.74, $1,279.80. Building contents 910,000 cu ft. Annual cost of fuel per 1,000 cu ft of space heated, $1.40.

Fuel report 1931-32, Cherry plus Feilbach, 338 tons screening at $3.19, $1,078.22. Building contents 1,660,500 cu ft. Annual cost of fuel per 1,000 cu ft of space heated, 64.9c

Save 75c per 1,000 Cu Ft

The stokers thus have brought about a saving of 75 cents per 1,000 cu ft, amounting to $682.50 per year for the Cherry school alone, to say nothing of the saving of the heavy capital investment which otherwise would have been necessary for a chimney, a boiler room, a fuel room and a boiler plant in the Feilbach school. The stokers have, in addition, eliminated the complaints formerly made of smoke from the hand-fired furnaces.

Cost of Fuel for Heating Schools

These observations have caused the author to search through his files to check up a little on fuel consumption in various schools; these being gleanings from magazines, engineering reports, etc. The table below is equalized on a basis of $4.00 per ton for coal in *Column A*, below.

Column B shows the values of *Column A* as modified by the different climatic condition in effect in Chicago. Chicago has 6,300 degree days. Rochester is south of Minneapolis, but we will use the same degree-day factor as for Minneapolis, which is 7,953. Toledo and Columbus are in about the same zone as to climate as is Cleveland, so we will use the Cleveland degree-day factor, which is 6,096. The values in *Column B* are arrived at by simple proportion, for instance as 173 tons at Rochester is to 7,953 degree days, so is x to 6,300 degree days.

	Cents per season per 1,000 cu ft	
	A	*B*
	As paid, converted to coal at $4.00 per ton	Converted to a common Chicago equivalent winter temperature and $4.00 per ton
All Blast Systems.		
No radiators in classrooms.		
Chicago Hand fired average for grade schools.	147	147
* Hand fired average for high schools.....	161	161
Toledo, O. Hand fired average for grade schools using steam fan engines and steam pumps	121	125
Hand fired average for grade schools, using electric fan motors and electric pumps...	126	130
* DeVilbiss High School, stoker fired.....	84	87
* Woodward High School, hand fired.....	72	75
Cherry-Feilbach School, stoker fired.....	82	85
Columbus, O. West High School, hand fired..	94	97
Split Systems.		
Radiators in classrooms.		
Rochester, Minn. Hand fired average for electric fan motors and electric pumps.....	173	137
Stoker fired average for electric fan motors and electric pumps.....	176	139
Columbus, O. McKinley Junior, hand fired with steam fan engines and steam pumps.	125	129
Indianola, Junior, hand fired with steam fan engines and steam pumps.....	115	119
* Central High School, stoker fired, with steam fan engines and steam pumps....	106	109
Toledo, O. Average of 16 room grade schools hand fired, with electric fan motors and electric pumps	147	152

* These high schools are used for night sessions, but it is impossible to tell how much such use increases the fuel demand.

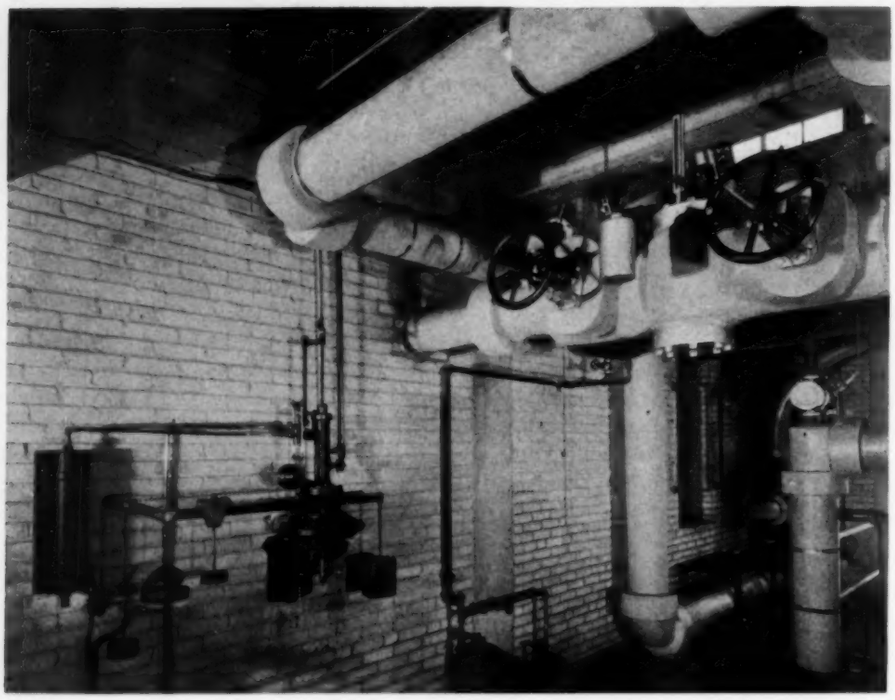
The all-blast systems in the big high schools listed are giving satisfactory heating service. They appear to be operating at a lower cost than do the split systems. The two big junior high schools at Columbus, nearly as large as the West High School, do not approach the economy of the latter, or the economy with which the two recent Toledo High Schools are running.

This tabulation in *Column B* is unfair, on its face, to the stoker-fired plants because they really burn coal costing less than $4.00 per ton, but it suggests strikingly that well-designed stoker plants are able to show savings due to better combustion even though we handicap them by an inflated price per ton.

$750 for Piping Change Cuts Fuel Bill $2300

Hospital Modernizes Heating and High-Pressure Piping • • Cuts Power Cost

By W. C. Gould* and Francis A. Westbrook†



One of the combination reducing valves, large diaphragm controller, and piping. This is part of the new piping which reduced the annual cost of fuel $2300. An additional $600 per month was cut from the power bill by reducing the steam through a unaflow engine which drives a generator

BY making changes in the arrangement of the steam piping and installing a unaflow engine considerable economies in the use of steam have been realized at the Beth Israel hospital in Boston; the $750 spent for piping has reduced the annual cost of fuel some $2,300. Annual fuel cost before the change was $15,300; after, $13,000. This work is a good example of what has been accomplished in plants, buildings and institutions during the past two or three years toward cutting costs.

The hospital is a group of five buildings served with steam for heating and for equipment such as autoclaves, sterilizing apparatus, cooking, etc. Steam required for heating the hospital ranges from 7,000 to 13,000 lb per hr, depending on the weather. About 2,000 lb of steam per hr is the high-pressure requirement. Service was formerly by means of two 6-in. steam lines operating at 85-lb pressure with a reducing valve at each building. These reduced the pressure to 3 to 4 lb for distribution and utilization, except for those services requiring high-pressure steam.

The changes made were extremely simple. A new high-pressure steam line was installed to supply the autoclaves, sterilizers and kitchen equipment. The reducing valves at the five buildings were removed from the original steam lines and a large-diaphragm combination reducing valve was installed in each of the two 6-in. steam mains, at the power house; these reduce the steam for heating from 130 to ½-1 lb, according to the weather. All regulating is done at this one point, where close supervision and control may be exercised.

The fuel saving is due to a number of factors. Overheating of the buildings has been reduced by varying the steam pressure, depending on the outside temperature; in warm weather only 6 oz is used. The improved means of regulation of the reducing valves at a central point is an important aid in reducing waste. Before, it was necessary to go to each of the five buildings when adjustments were called for at the reducing valves; under such conditions there was less efficient control. The maintenance of these valves is now less costly. With the low-pressure system it is possible to use the exhaust steam from the pumps which formerly was wasted. These exhausts are now connected in with the high-pressure returns from the sterilizers, autoclaves, etc.

A unaflow engine was installed several months ago in order to make as much use of the reduction in the boiler pressure as possible. The complete cost (including switchboard, circulating pumps, etc.) was $13,000 and the power bill has been cut from $1,100 to $500, or $600 per month. It is a three-cylinder vertical engine, direct connected to a 100-kw, 400 rpm generator which supplies electrical power for the whole establishment. The generator is run in phase

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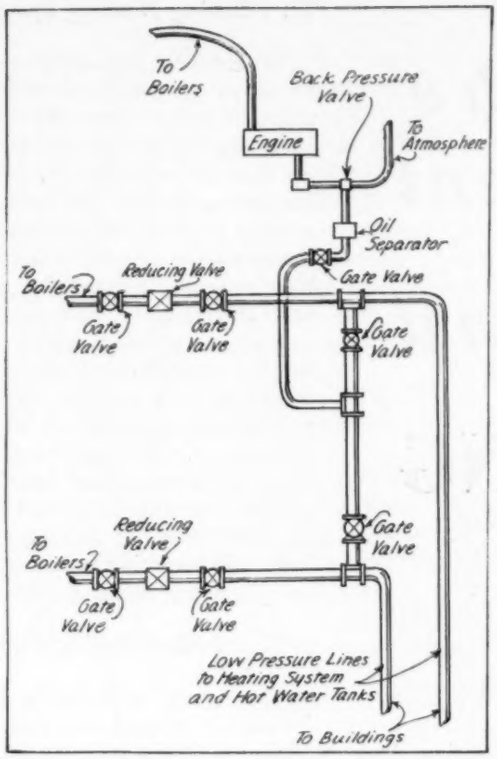

Sketch showing arrangement of reducing valves, high-pressure, low-pressure and exhaust steam lines. Either reducing valve can feed either or both low-pressure lines, or either or both can be fed with exhaust steam

with the utility system so that when requirements exceed its capacity the excess is automatically supplied from outside. Ordinarily the local generating unit is sufficient.

Except in winter the engine takes the place of the reducing valves. When it does not supply sufficient steam to keep up the pressure required adequately to heat the buildings, the deficiency is made up automatically by the reducing valves, which admit steam to the lines direct from the boilers.

In the summer the exhaust from the engine is used for heating the hot-water supply for general use, for the kitchen, laundry, operating room and other services. Little exhaust steam is wasted even during warm months.

The manner in which the reducing valves, the high-pressure steam line and exhaust from the engine, as well as the low-pressure steam lines, are arranged is shown in the accompanying sketch, which has been simplified in the interest of clarity to show only those pipes and connections which have a bearing on this discussion. It is seen that either reducing valve can feed either or both low-pressure lines, or that either or both can be fed from the engine. The lines can be fed from the engine alone, from the boilers alone or by both. This layout is simple and yet permits of complete flexibility in operation.

Modernize the Term "Square Foot"?

A TERM is needed to take the place of the *square foot* in speaking of ratings for all sorts of heating apparatus. It should be of somewhere near the same value as the present square foot or of some multiple of that value. It should be capable of easy translation into the metric system.

The term *therm* has been suggested, but seems not to be properly available since it is used in physics to denote the small calorie.

It would be most convenient if the new term meant 250 Btu, or any unit of heating surface area which would under stated conditions transmit 250 Btu. The difference between 240 Btu and 250 Btu is trifling unless the unit is multiplied manyfold. The advantage of using 250 over 240 is great in that it lends itself to metric translation.

Suppose we conceive of this unit as *ccl*. This term is not easy of confusion. Its Latin ancestry is authentic, *CCL* meaning 250. It is easily written; much more so than is the abbreviation for a sq ft. A 32-sq ft convector would be 32 *ccl*. Try writing it and see how easily it flows.

A steam main now good for 4,000 sq ft when 100 ft long would be good for 3,840 *ccl*, not enough difference to change a pipe size. A 10,000-sq ft boiler would be good for 9,600 *ccl*, again not enough difference to worry about; the manufacturer probably would, in reissuing his catalog, call it either 9,500 *ccl* or 10,000 *ccl* and let it go at that.

An engineer would compute the heat loss of a room, perhaps 5,500 Btu, and would find 21 *ccl*, for the convector to heat that room just as quickly and easily as he would find 23 sq ft. Calling the heat output unit a *ccl* instead of a *square foot* would simplify wonderfully the entire language of heating and cooling engineering.

The old hot-water square foot at 150 Btu presents a problem. It is 3/5 *ccl*. We shall see more hot water used in the future than in the past. Why not call it *cl* for the Latin *CL* and tell the truth about it—that it is 150 Btu? Instead of having to say, "800 sq ft of hot water radiation" we would say "800 *cl*" and there could be no misunderstanding. When 800 *cl* and 800 *ccl* are to be added we would soon learn to divide the *cl* by 5 and multiply by 3 to convert to *ccl*.—*Samuel R. Lewis.*

What Will be the Future Development of HEATING *and* AIR CONDITIONING ?

WHAT will be the future development of heating and air conditioning?

If anyone had predicted fifty years ago that the crude, unreliable, cumbersome internal combustion engine would make it possible for man to fly from coast to coast during the hours of daylight, or across the Atlantic, or, even if that were possible, that the development would be practicable and commercial, he would have been considered of unsound mind.

. . . . What prophet could have possibly foreseen a century ago the great development in power transmission and utilization through the medium of that intangible, mysterious form of energy — electricity? Today, we accept it as commonplace.

. . . . Who could have visualized the tremendous extent, or even the mechanical or economic possibilities, of our present automotive transportation?

. . . . Who could have visualized the development and tremendous use of the telephone as a means of communication, to say nothing of those marvelous little electric tubes that permit us to talk across oceans without any visible means of connection?

. . . . From which it becomes obvious that the forecasting of future developments in any field of technology is a difficult and dangerous task.

I shall not essay, therefore, to predict the future of heating and air conditioning but rather to point out the present existence of certain definite trends. These may progress to ultimate public acceptance, or they may in part fail and be supplanted by utterly new and unique methods and devices not now envisioned. For the human mind is limited in its imaginative powers to visualize applications and devices which not only have no rudimentary development but have no analogies in related arts.

In the field of heating there are in progress certain outstanding developments which will, in principle, ultimately receive general acceptance, being in the meantime subject to many additional improvements.

. . . Zoning Heating Systems

Among these, I would place first the zoned control of heat distribution for office and other large buildings. It is only recently that we have fully recognized the important part the sun plays in heating requirements necessitating changes of heat distribution from hour to hour as the position of the sun shifts from east to west around a building. The ever-varying direction and intensity of winds play an equally important part in the requirements of heat distribution. This control of heat distribution can either be accomplished thermostatically or by zoning and metering the supply of heat as is becoming quite common, or by a combination of both.

. . . Central-Station Steam

There will undoubtedly be an increasing demand for central-station heating plants supplying a large number of separate buildings. Not only will the required quantity of steam be metered to the buildings but its distribution will be zoned within the buildings themselves. Great advances have been made in this direction, but there is still room for much improvement.

. . . complete air conditioning will be accepted as an essential requirement in all modern structures.

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. . . Panel Heating

The deficiencies in many of the present methods of supplying heat to the room are recognized. It is believed we are about to see a general change in the method of heat application. There are two diverse ways in which this may be brought about. The present radiator heats both by radiation and convection. The panel system aims to accomplish the heating by radiation alone and to so distribute that radiation as to avoid undue intensities at any particular location and, in addition, to maintain uniform air temperatures on a lower plane. Much study will undoubtedly be given to the proper adaptation of this means of heat emission.

. . . Concealed Radiation

The second method is that of concealed radiation by which practically all of the heat is introduced to the room by convection. There is no objectionable radiation when sitting too close to the source of the heat, and good distribution of temperature can be secured at different levels.

. . . Forced Convection

A third method, which is growing rapidly, is that of forced convection, with air supplied from a central source and heat distribution either through air-volume control or individual convectors. This method controls ventilation, gives uniform temperature distribution, and permits air cleaning and humidification. It is a first step toward complete air conditioning; it permits supplying cool air instead of warm in rooms exposed to intense sunlight.

. . . Fuel Burning

Another improvement being made is that of heat generators. In the field of oil burning, boilers are being designed for steam and hot water for special application to a particular type of burner. This adaptation of burner and boiler considered as a unit, is a logical step in the evolution of oil burning and should result not only in considerably higher efficiencies but also in better and more reliable performance. Similar adaptations have been accomplished in the burning of gas. It is believed that gas in the future will be a stronger competitor of both oil and coal. Lower costs of manufacture, improved means of distribution, together with the utilization of gas from natural gas fields, may bring this about.

Various types of furnaces using coal are, however, not to be overlooked in this modern trend in development. The anthracite coal industry has been awakened to the requirements of the day. Relatively simple and inexpensive means of automatically handling coal and ashes have been devised. The aim is toward flexibility of operation and control corresponding to that of gas or oil fuels while at the same time doing away with the requirements of hand-firing or ash removal.

. . . Distribution of Conditioned Air

A new trend in comfort air conditioning is concerned with improved methods in the distribution of the cold air supply to prevent stratification and drafts. In certain

By Willis H. Carrier*

applications this is accomplished by increasing outlet velocity. Where formerly a register was placed in the side of the wall with outlet velocities ranging from 300 to 400 fpm, it is now possible to obtain better distribution and avoid drafts with a smaller and colder air supply using velocities as high as 2,000 fpm. If anyone had suggested such velocities to the old time ventilating engineer he would have shuddered. Other methods of control have been developed in which the amount of air dehumidified in summer is varied according to the requirements, but where the total quantity of air handled remains constant through the device of bypassing a portion of the return air.

Means are being developed for treating individual rooms, as in office buildings, so that while the air conditioning may be supplied from a central plant, the individual occupant of the office may adjust the heating or cooling to suit his own requirements, or even open the window if he wishes to without affecting his neighbors.

. . . Refrigeration for Air Conditioning

Great progress has also been made in the process of refrigeration applicable to air conditioning. Development of compressors and refrigerants is going forward. A new refrigerant, *freon* (Dichlorodifluoromethane, CF_2Cl_2) is now available.

Water, too, is being used as a refrigerant. During the last summer some thirty cars on the Santa Fe and other roads were air conditioned and cooled using only water as the refrigerant. The compression of the water vapor is accomplished without any mechanical means but through a simple and relatively efficient steam ejector.

Several restaurants and other places have been cooled in this manner during the past summer, and some larger installations may be expected to be in operation during the coming year. This method of refrigeration for air conditioning has many advantages where cheap steam from the street is available through the public utility companies. Its disadvantages lie in the necessity of disposal of a much greater quantity of heat from the condenser with a consequently greater increased amount of condenser water or cooling tower capacity. It is particularly adaptable to places where cheap and unlimited water supply is available.

. . . Air Conditioning Will Be Essential

Air conditioning for human comfort is definitely receiving general public acceptance. There will be many wild ideas regarding its cost and commercial possibilities, but eventually, and possibly before long, air conditioning will be accepted as an essential requirement in all modern structures, just as heating has been so accepted in the last 100 years.

*Chairman of the Board, Carrier Corporation.

Legalizing Beer Means

Modernization of Old Breweries

Before prohibition 1,100 breweries operated in the United States. Today 164 are still legally in existence under Federal permits for the production of near-bear. As near-beer is only real beer de-alcoholized, most of these breweries are ready to turn out real beer five minutes after the Volstead Act is modified. On hand under bond are less than a million barrels of beer which would last the nation not a week. So says *Time*, the weekly newsmagazine.

The return of beer would mean the rehabilitation of old breweries and the building of new on a scale which would permit production of more than 40,000,000 barrels annually, according to authorities. For such rehabilitation and building it is said that it would be necessary to expend $360,000,000.

In this article Mr. Doremus sketches briefly how necessary it is to rehabilitate with modern equipment such as room coolers and technically-designed mains. The piping in the new brewery must be designed in line with modern accepted practice rather than left to haphazard whim. No piping bottle-necks can be tolerated that affect capacity production. In the final analysis, regardless of the capacity of individual items of equipment, the plant is no better than its piping.

By R. C. Doremus*

THE settlement of the beer question in accordance with public opinion expressed in the 1932 election will cause many changes beyond the addition of a new law or regulation on statute books. The brewing business will be revived, old breweries that have lain dormant during these "dry" years will be rehabilitated and possibly some new ones built, all in an effort to satisfy the great American thirst. This activity will involve a vast army of workers, from architects and engineers planning the plants to equipment manufacturers and supply men—all interested in giving the brewmaster or plant manager the necessary equipment and materials.

*George B. Bright Co., Refrigerating Engineers and Architects, Detroit, Mich.

There are probably no two breweries in the country exactly alike in equipment or method. The art of brewing beer has undergone little change. However, more modern methods have been developed in certain parts of the process (especially in Germany) to facilitate handling of materials or to improve the product. These undoubtedly will be added as adjuncts to old equipment in order to modernize the apparatus or included in the construction of new brewing plants.

Largely a Steam-Cooking Process

The brewing process is one largely devoted to cooking by steam. The old breweries, especially the smaller ones, had hand-fired boilers and generated saturated steam with 2 or 3 per cent priming. This steam was used first for power in large-size, reciprocating, slow-speed engines, usually of horizontal type, to drive refrigerating compressors, electric generators, water pumps, beer pumps, etc., and the exhaust utilized—together with some bleeding of live steam—for heating brew kettles, water for mash tubs and miscellaneous uses. During the last twenty years, there has been a gradual transition from large size, slow moving, horizontal ammonia compressors to smaller size, higher speed, vertical compressors. Concurrently, we have enjoyed a period of intensive electrification which means direct-connected synchronous motors or short-center drives.

Modern Plants Want Dry Steam

As to fuel for the boiler plant, low-priced coal will be generally used. The largest brewery in Detroit has installed pulverized coal-burning equipment. Others are installing oil- or gas-fired boilers, according to location and fuel costs. Some are considering diesel-engine-driven generators for the power load, and boilers simply for heating and process work. In general, the more modern plants are installing mechanical stokers to replace hand-firing, and superheaters at higher pressures to obtain a drier steam. One great drawback to saturated steam has been the large amount of priming in the steam supply to the engines and the still greater amount of condensate in the exhaust used for subsequent heating. The brew kettles would become waterlogged, which diminished their output. The use of superheaters will avoid this, especially in electric plants where steam is used only for process work. Some plants incorporate oil-fired brew kettles to obviate this difficulty.

In the process of making beer, probably the most nota-

ble improvements have been in the methods of handling and mashing the grain; however, these are involved in the process and have little bearing on piping.

Flooded Ammonia Coolers Finding Favor

After the ingredients (including malt, rice, grits and hops) have been cooked in the brew kettle, the resulting wort is pumped at a temperature of approximately 180 F to a wort cooler where it is cooled to 40 F, to be placed in the settling tubs in the Rüh Keller. These coolers are of double pipe or baudelot type, in which the upper section is usually water cooled and the lower section cooled by brine or ammonia direct expansion. Cooling frequently requires from 6 to 8 hours for a 150-barrel brew and is a determining factor in plant capacity. Flooded ammonia coolers, which were developed primarily in milk cooling work, have been finding favor for this work because of high speed and capacity. Many of the old breweries are changing their coolers by adding float control for this reason.

The older plants still use brine systems for cooling wort and for attemperators in the fermenters. However, with the transition to flooded-type wort coolers, there is a tendency to substitute sweet water for the attemperators. This does the work of absorbing the heat generated in the fermentation process and also avoids spoilage of product in case of a leak in the attemperator.

Where the gravity system is used, little pumping of beer is required. Its flow is controlled as it passes down from the wort cooler (usually on the top floor) through the various refrigerated cellars—

Rüh Keller	42 F
Fermenting Cellars	38–44 F
Chip Cask Cellars	33 F
Stock Cellars	33 F
Racking-off Cellars	38–40 F

Unit Coolers Will Find Use

In addition to these refrigerated rooms, the hop storage must be maintained at 40 F and the Government cellar at 33 F. These rooms were formerly cooled by brine or direct-expansion coils on walls or ceiling by gravity air circulation. Unit coolers with forced draft circulation are bound to find widespread use, for they may be placed in small floor space or hung from the ceiling, allowing more usable cellar space. These will be used in all cellars except the hop storage and fermenting cellars where ventilation or drafts must be avoided. These coolers may be obtained for brine or direct expansion.

It is apparent that the legalizing of beer of a certain alcoholic content will be governed by strict regulatory measures and taxes, both Federal and State. As the brewing process itself requires a definite time cycle, economies must, therefore, be effected in manufacturing methods.

ON THE JOB

. . . a department devoted to short, practical articles on the installation, operation and maintenance of air conditioning, heating and piping equipment . . . . . .

Modern Maintenance Spots Waste in Piping

By . . . . . W. H. Wilson

MUCH thought should be given to the selection of equipment that is suitable for modernization with careful consideration given the initial cost, maintenance and the results desired. The selection of equipment that will conform to all requirements is not a simple matter; in order to handle the situation properly and successfully it is essential to have definite information as to what is needed.

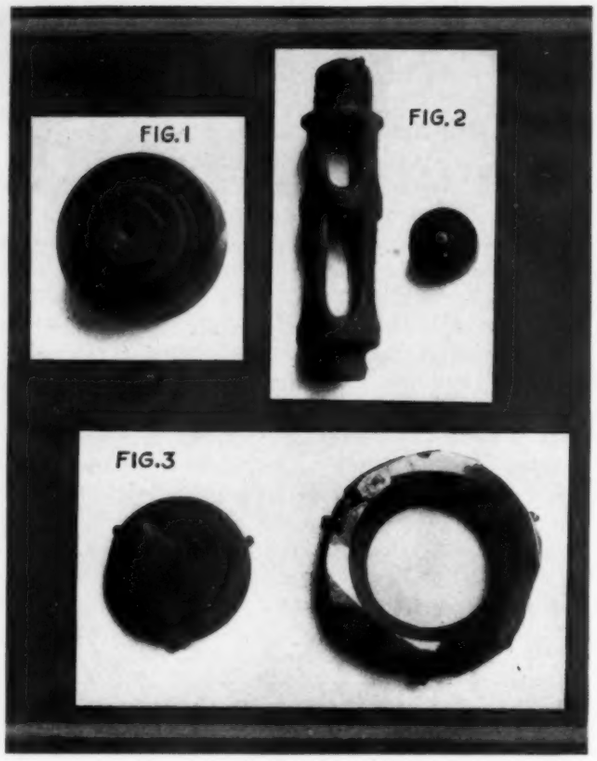
Look for Sources of Waste

To obtain accurate information as to the amount of steam, compressed air, gases, oils, water and other liquids that are required in process work with a view to proper and economical modernization, recording-type flow meters can be used to advantage in computing pipe sizes and selecting suitable equipment.

It is not always necessary to purchase a number of instruments to obtain this information; a few meters can be used for short periods at various locations. The quantity as well as the rate of consumption at different periods can be determined, all of which is definite information and of material assistance in preparing for modernization. Accurate metering eliminates guesswork and furnishes correct information for the basis of estimating future requirements. If it is necessary to purchase meters for use in obtaining this information, they can be selected for use in the permanent installation.

An inspection of reclaiming devices for the condensation from steam lines and equipment using steam, the pressure reducing and controlling valves, and the

These illustrations show how equipment and appliances are allowed to get into bad condition. Bypass valves particularly should be checked for leakage; a check of all existing piping equipment will point to opportunities for profits in repairs or replacements



invisible leaks from other sources, would disclose some interesting and startling information in many plants.

Condensation is frequently allowed to escape to drains and sewers. This may be because of the heating and process-steam units being located some distance from the steam-generating plant, making it necessary to install a long return line, properly insulated. Possibly there may be obstructions in the way of locating the conduit or tunnel for this return line. This may make the installation expensive and the question arises, Does it pay to save the condensation under these conditions? Sometimes it does not.

The advisability of utilizing the condensation should be carefully considered. It is pure water and usually has a high heat value. Heat discharged in condensation continually, apparently only a small quantity, will amount to a considerable item in a few weeks' time. It is advisable to run a test by measuring or weighing, for a short period of time, the condensation that can be reclaimed under actual operating conditions. This will give a basis for estimating the savings against the cost of installing piping and equipment for utilizing the condensation. Small pumps on the market can be operated economically as regards maintenance and power costs. These may be used to return condensation through an overhead line. Discharge and return lines should be of a size as small as possible and free from sharp turns or other obstructions to the flow so that the condensation reaches the feedwater heater (or wherever it is to be used) with as little heat loss as possible.

Bypass valves should be checked carefully for leakage. When these valves are installed near machinery, the noise caused by the pressure escaping through a leaking valve cannot be readily detected. Fig. 1 shows a disc that was removed from a bypass valve on a steam line; the renewable portion is worn and broken so badly by the escaping steam that the loss of steam pressure is evident and proof that the valve had been leaking through for some time. Fig. 2 shows two discs, each taken from a different reducing valve. The longer disc is from a 1½-in. valve. The trouble experienced with this valve was corrosion due to traces of boiler compound and impurities in the steam which caused the valve disc to stick tight in the wide-open position. The reducing valve naturally failed to govern the supply of steam, with the result that the full line pressure was on the delivery side of the valve continually. The small round disc in this figure is a metal disc from a ½-in. steam reducing valve of the single seating type. The scored face of the disc shows that the valve had been allowed to leak through for some time. Fig. 3 shows a disc and a part cut out of a steam reducing valve, showing the seating surface (the rough interior ring). This valve, which was of an expensive make, had been allowed to get into this condition. It is evident that it was not giving satisfactory and economical results.

These illustrations show how equipment and appliances are allowed to get into bad condition. This is not only true of valves, but of strainers, gages, lubricating devices, governors and many other things connected with plant heating and piping systems.

It is well to check over existing piping equipment. This will bring out many helpful suggestions that will prove worthwhile and valuable. For example, it is not always necessary to install a bypass valve on reducing, governing and control valves.

If a reducing valve is used only at certain times and is not required for continuous operation, it is not necessary to follow the set rule of putting in a bypass connection. If it becomes necessary to inspect or repair the valve, shut down, take the valve apart and make the needed repairs. If on the other hand, it is essential to supply reduced pressure continually and accurately install a bypass connection with a suitable valve that can be set for throttling the supply, so that in case it is necessary to repair the reducing valve, it can be shut off for this purpose and uninterrupted service furnished by hand control of the bypass valve. Bypass connections are useful when necessary, but each one is one more valve to look after.

A check of existing conditions will bring out many points that can be used to advantage in modernization. Many automatic appliances are installed with no provision for dismantling when inspection or repairs are necessary. This delays the repair work, especially when the apparatus is of large size, heavy and located in places not readily accessible. A close inspection and the repairing of existing equipment will show that the maintenance man is entitled to consideration. It is easier to change piping connections and valve locations on the drafting table than in pipe galleries and tunnels.

MODERN EQUIPMENT

for

SAVINGS

and

PROFIT

In the following pages is presented a summary of modern heating, piping and air-conditioning equipment. As has been mentioned previously in this issue, modernization has not kept pace with engineering advance. More new and improved equipment has been developed in the last three years than in any similar period in history, and it is such equipment that enables the economies and profits shown in foregoing articles to be possible in the plants and buildings described—and which are possible in most plants and buildings.

The aim in this presentation has been to classify equipment and materials by kinds and to show particularly what they have done or what they are capable of doing in saving or making money in operating heating, piping and air-conditioning systems or improving the service rendered. Thus, from each classification the reader can obtain application information on a type of equipment to enable him to judge its adaptability to his particular plant or building and then can obtain a comprehensive knowledge of the features of the particular makes of equipment which are available.

In the space permitted it is obviously impossible to give detailed information on every make of equipment or even on every class of equipment. Sufficient coverage has been possible however to show the reader the wisdom of studying carefully this proposition of modernizing as today's opportunity for meeting business conditions with the economies and profits he can effect through replacements, changes, and additions to his heating, piping and air-conditioning systems.

. . . . . the Committee on Industrial Rehabilitation is attempting to carry to the industrial world a simple message of law and order to the effect that the financial panic has passed; that recovery has begun its slow course; that we can speed it up to our own advantage if we will proceed now to take advantage of present prices and present markets and spend whatever money we should spend for necessary things."—A. W. Robertson at the annual meeting of the American Society of Mechanical Engineers. . . . . . .

How Modern Heating Equipment Saves

HEATING is a major service in every plant and building and is essential to the use of any such structure. Whether a plant be running at 100 per cent or 50 per cent of capacity, it must be heated; a building half-occupied must provide the same satisfactory temperatures for its tenants as one fully occupied, or it will soon be vacant. But a few degrees above or below the proper temperature destroys efficiency of workers. It should be constantly borne in mind that the prime function of a heating system is to heat but that a wealth of opportunities exist to reduce the cost of this important service—and in many cases improve the results—by proper engineering and modernization.

Because heating is a major service, many different systems for heating are available and each has its applications which depend on the type of building, the locality and numerous other factors. The right system for the particular building is obviously essential. Steam, hot-water, vacuum, vapor, warm air, district steam, etc., all have their special features, which must be considered.

Developments in heating have been many in recent years and the types of equipment are so numerous that it would be impossible to cover them in any one issue. Past numbers of this publication have described the systems installed in plants, office buildings, hotels, hospitals, schools and other large structures. On these pages representative types of equipment which apply to modernization of heating systems are described briefly; where possible, reports of typical cases of modernization have been included, to suggest the possibilities.

Not to be forgotten in considering heating modernization is the building itself and the means which can be provided in its construction and operation for conserving heat. Following paragraphs show that the application of some form of control produces good results in cutting cost and improving results. The fuel and its handling and firing often may be changed to advantage. The heat-emitting surface is not to be neglected—many developments have been made in radiation and convector heaters. The piping and corrosion are sources of potential extravagance if the right material is not used. The boiler or furnace is obviously an important and not-to-be-overlooked item.

Control Cuts Cost

THE importance of the conservation of heat in plants and buildings is better understood when it is realized that in the north central states in a well-operated building with 85 per cent occupancy 8 to 15 cents is spent each year for heat for each square foot occupied, according to L. K. Ferris. Assuming a saving of 2½ cents per sq ft of rentable area per year and a moderately-sized building of 300,000 sq ft of rentable area, the possible savings amount to $7,500.00—very worthwhile.[1]

Must Not Impair Service

In investigating the possibilities of modernizing control as a method of cutting heating costs, it should be constantly borne in mind that the primary function of a heating system is to heat the building to the satisfaction of the occupants. In considering the several variable requirements that go to make up the heat required by a certain building, it is evident that the opportunity for saving through the use of some methods of control depends to a large extent—if not entirely—on the elimination of overheating. When this has been done, the control equipment has fulfilled its economic function.

Control Has Saved 25 to 40%

With the natural stress on operating economies during recent months, the opportunity for modernizing heating systems, and the numerous developments that have been made in this phase of heating engineering, many plants and buildings have found it possible to install equipment to improve utilization of heat to reduce costs far below those formerly considered satisfactory. In his previously-mentioned paper, Mr. Ferris quotes the results of a study made by the commercial relations committee of the *National District Heating Association;* the average reduction in steam consumption on the degree-day basis in 52 buildings was 17.8 per cent following the installation of control equipment. In some cases, the improvement resulted in reported savings amounting to 25 to 40 per cent.

Several general types of control equipment are available; among them are intermittent control, orifice control, high-vacuum control, zoning, etc. Each of them assumes intelligent operation and the maintenance of satisfactory—yet economical—building temperatures.

Institution Saves $1,642.50 on Coal

One of the methods used in modernizing and reducing steam and fuel consumption is the application of the zone control system (Illinois Engineering Company, Chicago) to an existing steam or hot-water heating plant. The control may be applied to one-pipe or two-pipe gravity steam systems, vapor or vacuum systems, or to hot water circulation. The equipment consists of electrically-operated pressure-reducing or stop valves, a panel board, and one or more of the necessary controlling thermostats of which the infiltration

[1] "Lower Operating Costs Through Heating Efficiency," by L. K. Ferris. Presented at convention of *National Association of Building Owners and Managers,* Chicago, June, 1932.

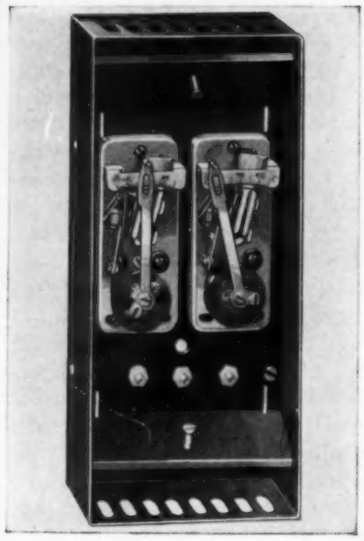


Fig. 1—Infiltration thermostat to control temperature on basis of outside temperature plus effect of infiltration. It is mounted at radiator height on the inside of an outside wall; the dampers shown in this rear view are adjusted when installed to control air flowing up through the intrument

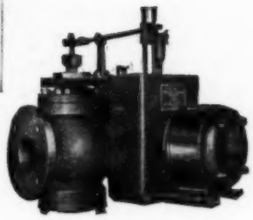


Fig. 2—Master control valve of the type applied to the three buildings of a university; $1600 was cut from the coal bill

thermostat shown in Fig. 1 is a recent development.

As an example of what may be accomplished by the application of this control equipment to existing plants to promote economy, an instance taken from an installation of this equipment in three of the buildings of a college is cited. After observation and test of the operation of the equipment during the heating season of 1931-32, as compared with previous heating seasons prior to the installation of the equipment, the institution reports a saving in coal consumption of $1,642.50. The cost of the installation of the controls, without panel board for the three buildings, was approximately $1,000.00.

Data on the steam required for heating the C. A. Verner Company building, for the season of 1931-32, show the lb of steam consumed per cu ft of volume to be 3.9 while the comparable figure for steam consumption before the control was installed in October, 1931, was 7.33 lb.

Metering Orifices Feature One Method

The steam variator (Warren Webster & Company, Camden, N. J.) shown in Fig. 3 has been developed in recent months; it is a steam-heat control valve suitable for use with low-pressure steam-heating systems of 1,500 sq ft and up direct radiation. The variator control may be employed with the improved Webster vacuum system or the improved Webster vapor system.

The systems mentioned are distinguished by the use of metering orifices in all radiators, and in larger installations intermediate metering orifices in branch mains. In sizing these orifices, consideration is given to the size of the radiator or the heat requirements of the room, the distance of each radiator from the boiler or initial point of distribution, the size of the piping and the extent of vertical flow, *i. e.* the altitude. By balancing the distribution of steam in this manner delivery of a given amount of steam into the supply main is accompanied by proportionate distribution of this steam to each of the radiators, and it becomes possible to apply a single control valve, or throttle. Adjustment of the weights on the levers of the variator makes it possible to control the steam delivery down to approximately 1/10 lb pressure difference between supply and return main. At this pressure steam delivery to radiators is approximately one-third that obtained with a filled radiator. When heat is required at a higher rate than this the weights can be moved, resulting in an increased pressure difference and a correspondingly increased delivery of steam to all radiators.

Two other elements play a part in this type of control; one is a switch which enables shutting off the steam supply during periods when the building is unoccupied. The same switch serves to throw the motor which controls the shut-off of the valve into circuit with an indoor thermostat which is used as an overheat limit control. This control is used only in very mild weather when resort is had to intermittent heating to still further reduce heat delivery below the 33 per cent rate obtainable by adjustment of the weights.

Controlling 477 Unit Heaters

The Starrett-Lehigh building, New York City, embodies several interesting features. Unit heaters located around the space between the columns and windows prevent the heat loss through its large glass areas from chilling the inside spaces. The 477 heaters circle the building, so that the air flow set up is in one direction.

The temperature-control system consists of the dual-type thermostats for day and night operation, and the zone control apparatus in the basement.

Each thermostat is centrally located as regards the group of unit heaters it controls (see Fig. 4) and is mounted on a cabinet which contains the auxiliary control equipment. Inside of each thermostat are mounted two bimetallic elements, each of which has a range of 55-85 F. In this particular installation one of the elements is adjusted for a day temperature of 70, the other for a night temperature of 55.

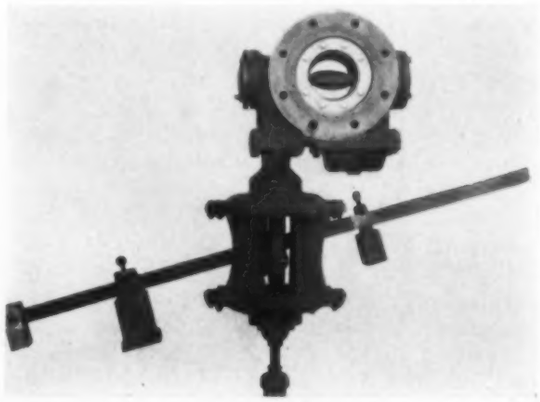


Fig. 3—By adjustment of the weights on this steam-heating control valve, pressure between the supply and return mains may be controlled to vary steam delivery to the radiation down to 33 per cent that obtained with a filled radiator. Orifices in the radiators and branch mains assure proportionate steam distribution

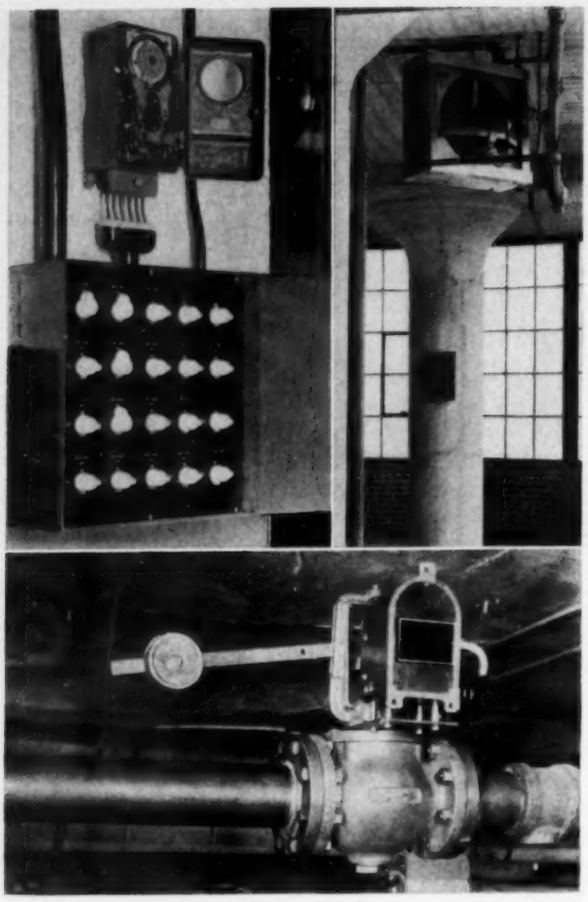


Fig. 4—Dual thermostat and cabinet controlling group of unit heaters, motorized valve controlled by thermostat, and master control clock and zone control board in Starret-Lehigh building. Similar control equipment—and other improvements—in the Hart Manufacturing Co. plant cut the annual fuel cost some $1600.00

Another interesting zone temperature control installation is at the Hart Manufacturing Co. plant, Hartford, Conn. Prior to installing the control, it was difficult to secure a temperature above 65 F for the top floor, and too high a temperature on the first and second floors on the south side of the building was the rule.

Each floor of the building was split into five zones, each controlled by a dual thermostat connected to a motorized valve. All thermostats are connected to and controlled by a master clock in the boiler room, which automatically shifts the temperature from the day to the night thermostatic element and vice versa throughout the week until Saturday noon and shifts the control of the night element and holds the temperature at an economically lower level until Monday morning, then bringing it back to the day level.

In 1929 the fuel cost for this building was $4,905.75. At the beginning of 1930 not only was the temperature control equipment installed but also a larger boiler, and an additional annex building was added to the heating layout. The cost of fuel for 1930 was $3,311.93, or a reduction of $1,593.82. In 1931, the fuel cost was $3,208.52.

The control equipment used on these two jobs was made by The Stat-Amatic Instrument & Appliance Co., Hartford, Conn.

Outdoor, Radiator Temperatures Actuate Control

The duostat (F. I. Raymond Company, Chicago) offers a method of modernizing heating systems and is applicable to steam, vacuum, vapor, and hot-water types. It may be applied to both one- and two-pipe systems. This device operates by a combination of outdoor and radiator temperature, the principle being to vary the average temperature of the radiator—by partially filling it with steam—so that this radiator temperature is maintained in the proper relationship to the outdoor temperature.

The control itself, Fig. 5, consists of two thermometer bulbs connected through two long flexible tubes to the fixed end of a hollow coiled spring, attached to an axle at the other end and free to rotate. Bulbs, tubes and spring are filled with a liquid which expands when heated and contracts when cooled. Expansion of the liquid causes the spring to uncoil and rotate the axle, upon which a mercury switch is mounted which makes or breaks an electric circuit to control an automatic steam valve.

One of the bulbs is placed outside and the other on the radiator; the outdoor bulb cooling causes the steam valve to be opened and the radiator bulb heating forces the liquid back into the spring to result in closing the valve when the proper radiator temperature is attained.

Based on meter readings, total steam used for heating 22 buildings in Indianapolis served with district steam in 1929-30 was 80,129,000 lb; after installation of this type of control in each of the buildings, steam consumption for 1930-31 was 63,048,000 lb, a reduction of 22.4 per cent.

Stresses That Economies Are Possible

One manufacturer of self-contained, automatic radiator control valves (Capitol Brass Division, Bohn Aluminum & Brass Corporation, Detroit, Mich.) stresses the advances in heating made during the past three years. In securing economies through better control of heating systems in plants and buildings, this company feels that the following should be realized:

"In defining the possibilities of the control valve as an agency for effecting steam savings, we subscribe to the theory that the first job of any heating system is to heat the building, and in this connection the sev-

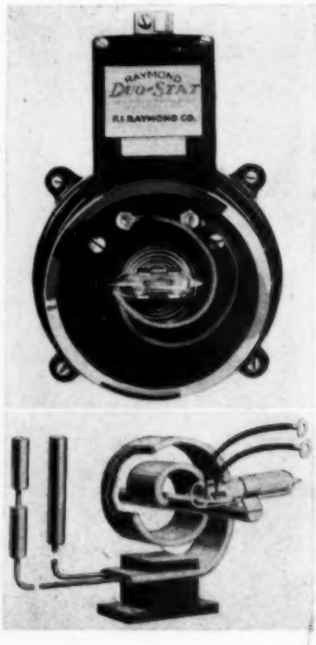


Fig. 5—Control which operates by a combination of outdoor and radiator temperature

eral variable requirements for heat that go to make up this demand in a building must be considered. The saving that can be effected is based entirely on ability to eliminate overheating. What is overheating and when is a room or space overheated? We believe that the occupants' demand has something to do with this and must surely be considered, especially in a tenant-occupied building.

"When a control valve has performed its function, and is closely controlling every room and space in the building at the minimum temperature that the occupant will allow, the largest possible economy for that particular building, consistent with the idea that we are to heat the building to the satisfaction of the several occupants, has been made."

Dual System Finds Increased Usage

Another company (Johnson Service Company, Milwaukee, Wis.) mentions numerous applications of its dual system of automatic temperature control in rehabilitating heating systems during the past two years. While this system is not new, it has found increased usage in recent months in providing a uniform operating temperature during periods of occupancy and a reduced "economy" temperature in unoccupied portions of buildings.

Expansible Liquid Operates Valve

A unit heater regulator (Fulton Sylphon Company, Knoxville, Tenn.) which gradually opens its valve to modulate the steam supply to one or a gang of unit heaters is illustrated in Fig. 6. Its major parts are a steam valve and an adjustable thermostat connected with flexible tubing. The thermostat contains an expansible liquid which, when room temperature rises above that for which the instrument is set, forces its way through the tubing to the chamber above the valve. This liquid is vaporized to create a pressure to overcome the spring pressure which normally holds the valve open. When the liquid is cooled, vapor is withdrawn from the chamber and the spring is allowed to open the valve to maintain the desired room temperature.

Fig. 7 shows two radiator valves for individual room temperature control also developed by this company. The lower view shows the valve for exposed radiation. It may replace the ordinary radiator valve in many cases, and therefore is adaptable to existing buildings.

Controls Modernize School Plant

A self-contained radiator control valve, an electric clock thermostat and a motorized zone control valve used in one type of control system (Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.) are illustrated in Fig. 8. With this type of control system, modernization may be readily accomplished with a minimum of disturbance and expense.

This system is entirely electric in its operation with the exception of the self-contained radiator valves. The result is that all connections to controls are made with standard wiring which can be concealed, are easily installed and are not subject to deterioration. The flexibility of the system makes it possible to fit it to the needs of the building and it is unnecessary to install oversize or excess equipment.

The heating system of the Glenwood school, Glenwood, Minn., was modernized with this type of control with the following results.

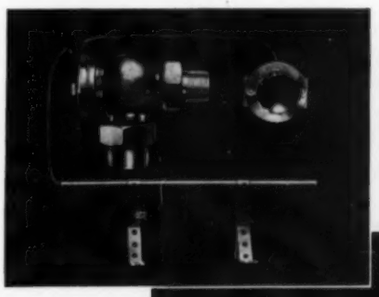
Month	*Cost*	*Av Temperature*
	1931	
Jan.	$166.60	18.5
Feb.	152.95	25
Mar.	100.30	27.4
Total	$419.85	Av 23.3
	1932	
*Jan.	$106.80	8.9
Feb.	96.40	13.6
Mar.	83.40	17.5
Total	$286.60	Av 13.3

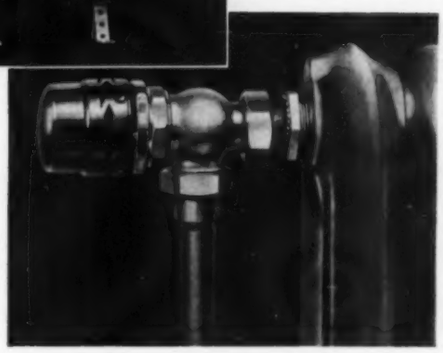
*Controls installed January 1, 1932.

For the period covered by the above data, the self-contained radiator control valves alone were installed. Since that time it has been decided to apply the electric clock thermostat with week-end shut off and the motorized valves, the purpose of these being to provide lowering of temperature overnight and over the week-end, with automatic return to daytime or occupancy temperature in the mornings and on Mondays following the week-end shut down.

Fig. 6—Regulator for controlling one or a gang of unit heaters by modulating the steam supply. An expansible liquid acts to close the steam valve when the room temperature rises

Fig. 7 (Bottom)—Radiator valve for individual room temperature control applied to exposed radiator. (Top) Similar valve for controlling enclosed radiation.





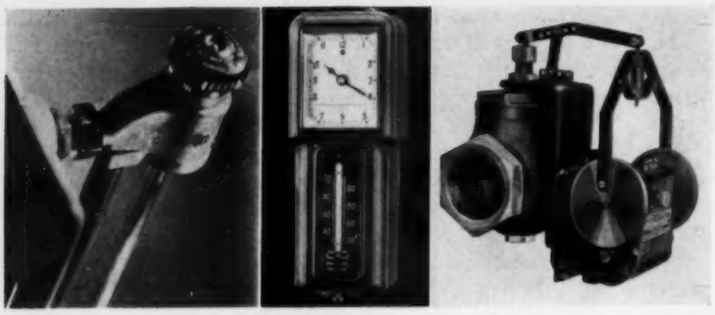


Fig. 8—Control equipment for modernizing heating systems which is entirely electric in operation except for the self-contained radiator valves

New Thermostatic Time Control Combination

A thermostatic-time control combination consisting of a thermostat and a synchronous electric time switch with built-in low voltage relay (The Mercoid Corporation, Chicago) has recently been introduced. The thermostat unit consists of two single thermostats with independent adjustments for setting the operating range of each. This instrument operates on a temperature variation of ½ F above or below the point set, an adjustment being provided to increase the differential to 3 degrees.

Thermostatic regulation is provided by adjusting the dual thermostat for the desired day-and-night temperatures, and connecting it with the time switch and relay combination. The time switch automatically transfers from day to night setting, or vice versa, at any predetermined time. See Fig. 9.

Reports Steam Saving of $2,754 in Year

A saving in steam amounting to $2,754 the first year after modernization of the heating system in the 200 Madison Avenue Building, New York City, is reported. This rehabilitation was done in 1930, and the saving quoted is for the year January, 1931, to January, 1932.

Fig. 9—This dual thermostat and electric time switch with built-in low-voltage relay may be used for modernization by better heating system control

Other advantages which were obtained are increased tenant satisfaction through the maintenance of constant temperatures and the elimination of overheating.

The vacuum-return-line heating system was modernized by changing it to differential operation (C. A. Dunham Company, Chicago). New equipment installed comprises a differential pump, two automatic control valves with thermostats, and regulating plates in the inlet valve of each radiator.

The heating system contains 44,000 sq ft of radiation divided into 810 radiators. The building has a volume of over 7,000,000 cu ft and a gross area of 540,000 sq ft. The heating system is fed up and down from the ninth floor; steam is bought from the New York Steam Corp.

Stokers Modernize Plants

WHEN investigating the chances for modernizing and rehabilitating the fuel-handling and firing equipment in plants and buildings in order to reduce the cost of operating heating systems or secure improved results, the need for a careful engineering analysis of the particular installation should not be lost sight of. Usually, the securing of competent engineering advice is indicated. A number of factors influence the selection of the right fuel; in one instance coal may prove proper, in another gas may be indicated; in a third, perhaps oil should be chosen. Purchase of steam from a utility or an adjoining building may prove the proper engineering thing to do. Opportunities for utilizing exhaust steam of course should not be overlooked.

Stoker in Plant Cuts Cost $1,500

Installation of a stoker (Detroit Stoker Company, Detroit, Mich.) and the necessary instruments to aid proper operation (three-pen recorder for steam flow, stack temperature and CO_2 and indicating draft gage) at the American Colortype Co. plant, Chicago, was completed about the first of last January; the cost is given as $2,927.44. The 150-bhp boiler is of the HRT type, and the load is for heating only—no process or power steam. The stoker is guaranteed to develop 150 per cent of the boiler rating as a maximum. The original fuel used was Pocahontas; stoker fuel, Big Ben screenings.

From the time the installation was completed in January, the saving in fuel cost to the end of last Spring amounted to $1,500, a worthwhile return on the investment.

Four Stokers Save $385 per Month

One of the first installations of a new stoker-unit (Combustion Engineering Corporation, New York) recently announced and illustrated in Fig. 10 has already shown appreciable savings. The four units installed are part of the heating equipment in a large apartment building in a New York suburb, and have been in about

two months. Based on an average taken from the actual records for the three-year period ending Jan. 1, 1932, the yearly fuel and heating cost with hand-firing was $11,879, a monthly average of $990. Reduction in the amount of coal used, lower ash-handling and labor costs, etc., have resulted in an average monthly cost of $605, or a saving of $385 a month. The cost of installing the stoker equipment was about $5,400. It is interesting to note that the savings run about 10 per cent greater than was estimated.

Rehabilitation Job Divides Fuel Bill by 3

Fig. 11 shows the application of two stokers (Motor-stoker Corporation, New York), to two boilers—one a heating boiler and the other a high-pressure boiler supplying process steam. When the building was designed, no provisions for coal storage were made; when the stokers were installed an outside coal tank was provided and buckwheat anthracite is piped by an automatic conveyor into the stoker hoppers. Automatic ash removal into a battery of two standard-sized cans is provided.

This rehabilitation work—the job is in Providence, R. I.—has cut the fuel bill to one-third its former amount.

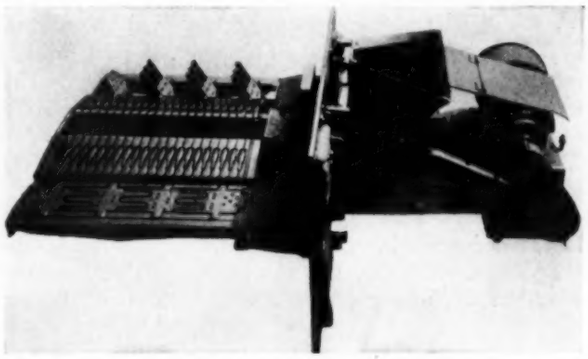


Fig. 10—Underfeed stoker for application to heating and industrial boilers in the approximate range of 40 to 150 developed boiler horsepower

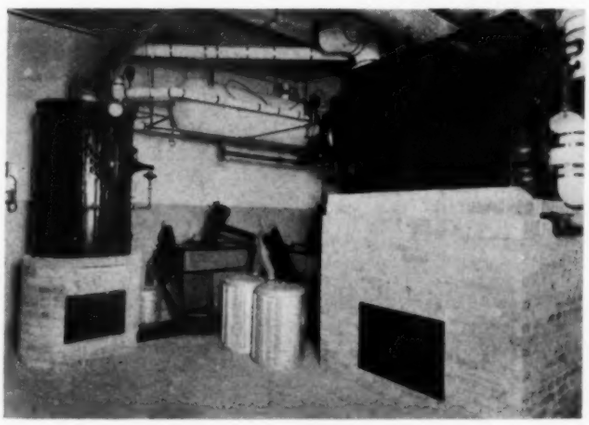


Fig. 11—Stokers installed under a heating boiler and a process-steam boiler, formerly gas-fired

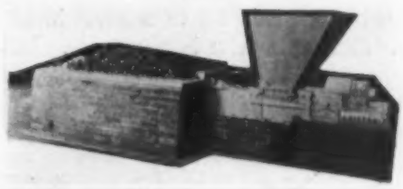


Fig. 12 — Hydraulic underfeed ram-type stoker which has reduced tonnage and enabled burning a cheaper grade of coal on a number of jobs

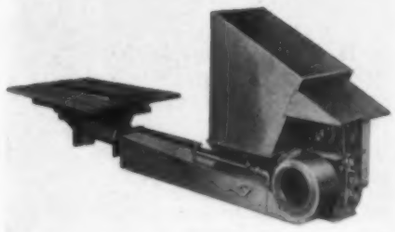


Fig. 13—Stoker employing non-agitated forced underfiring, which has good modernization record

Stoker Not a "Cure-All"

In connection with the application of the hydraulic underfeed ram-type stoker (Orr & Sembower, Inc., Reading, Pa.), illustrated in Fig. 12, the manufacturer points out that stokers are not a cure-all for all ills which may be found in a boiler plant. It is stressed that the ability of the boiler to absorb the heat produced and evaporate the water will, after all, determine the ultimate results and that proper boiler setting and stack conditions must be considered under this head. In addition, the human element is not to be neglected; stokers are not installed for the specific purpose of eliminating labor, but to reduce the physical strain on the firemen, enabling them to give more attention to economical operating conditions.

If properly operated, says the manufacturer, the stoker will effect a saving in tonnage and make possible the use of cheaper coal.

Has Good "Modernization Record"

A stoker (Iron Fireman Mfg. Co., Cleveland, O.) which has a good "modernization record" on several installations is shown in Fig. 13. It employs a non-agitated, forced underfiring principle. On a greenhouse job, the average annual per cent return on the stoker investment is shown by an audit to be 60 per cent; in a chain of five garages in which stokers were installed, a saving of about 55 per cent on the cost of fuel alone was obtained, the stokers first being in operation in the winter of 1931-32; the first year of stoker operation in a high-school showed a $1,555 saving in the cost of fuel alone, a one-half reduction in the cost of ash disposal, and other advantages.

Records Show Self-Liquidating Economies

About seventy per cent of the stokers (Hoffman Combustion Engineering Company, Detroit, Mich.) of the type illustrated in the installation view Fig. 14, are applied to modernization jobs, either to replace obsolete equipment or hand firing. From records of the manufacturer, it is stated that operating economies have been made which make the investment self-liquidating

in an average period of fourteen or fifteen months; some have paid for themselves in as short a time as six months and others in two years. Installations have been made in a number of institutions, penitentiaries, plants, etc.

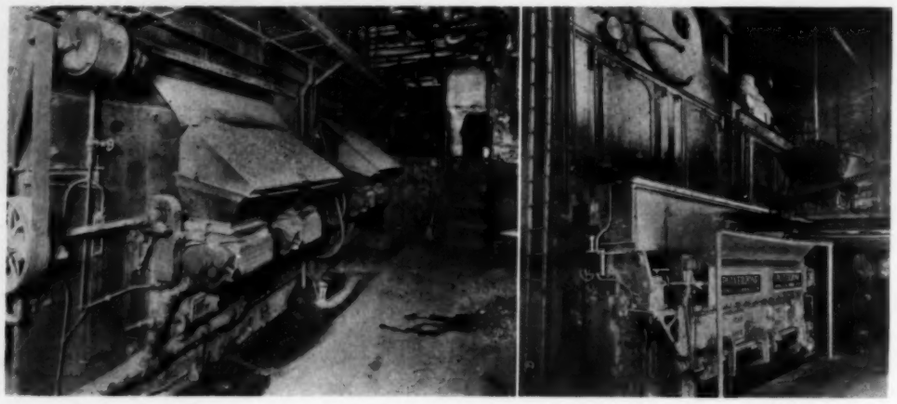


Fig. 14 (left)—Stokers in the Fort Shelby Hotel, Detroit.

Fig. 15 (right)—Installation of coal-burning system which combines pulverized fuel burning with mechanical stoker firing. Tonnage of fuel burned on the job shown was cut 25 per cent

Combines Stoker and Pulverized Coal Firing

A coal-burning system which combines pulverized fuel burning with mechanical stoker firing, and includes automatic damper and combustion control in one unit (CoKal Pulverzone Corporation, Chicago, Ill.), is shown in Fig. 15. On the job shown—a plant occupied

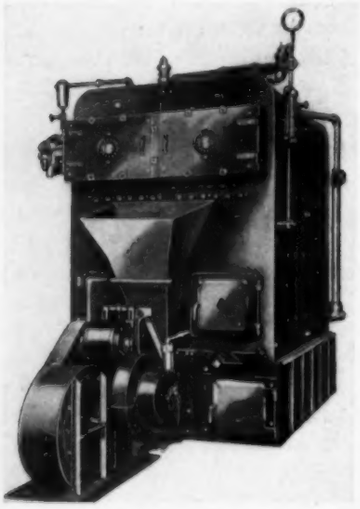


Fig. 16 — Stoker-boiler unit, constructed in two sections for ease of installation in existing buildings

by several manufacturers—tonnage of fuel burned has been reduced 25 per cent and unit cost of coal cut from $3.30 to $2.20. In another installation in a Chicago club building, a saving of 20 per cent in the cost of fuel was secured through reduction in the tonnage required.

Stoker-Boiler Unit for Modernization

A stoker-boiler unit (Spencer Heater Company, Williamsport, Pa.,—Riley Stoker Corporation) adapted for use in new or existing buildings is shown in Fig. 16; with modernization applications in mind it has been designed in two sections (with bridge wall built in) to permit placing of the boiler in the building with minimum disturbing of the foundation walls.

The unit is furnished in capacities ranging from 6,400 to 40,000 sq ft of radiation. The stoker is a side-dump, ram-type; the boiler was designed for rapid water circulation, high overall efficiency, ample water volume, and compactness.

Oil Burner Modernizes Heating Plant

A school heating plant just recently modernized with an oil burner (Julian D'Este Company, Boston, Mass.) is shown in Fig. 17; costs are not yet available. This burner is available in two commercial sizes, up to 3,000 and up to 10,000 sq ft of equivalent radiation.

Boiler Developments

The steel-welded type C boiler of Kewanee Boiler Corporation, Kewanee, Ill.. has been available for some years, but the maker states that perfection of various

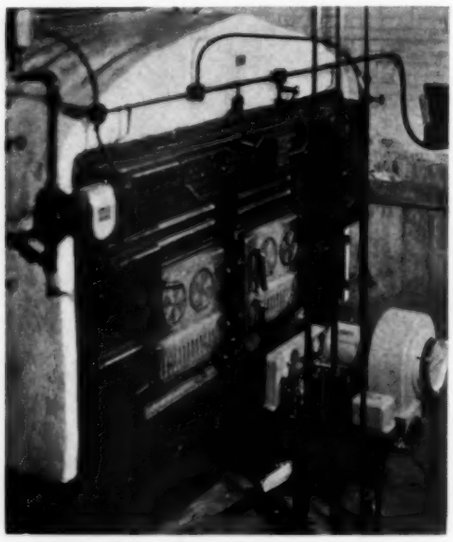


Fig. 17—School heating plant recently modernized with an oil burner

details connected with its application to different fuels is constantly in progress. This boiler is popular for modernization of heating systems in office buildings, hotels, hospitals, schools, apartments and other large buildings, it is stated.

A new low-pressure water-tube boiler has been announced by Murray Iron Works Co., Burlington, Ia. Two small water drums are located above the grates of the boiler, one at the front and one at the back of the furnace and extending from side to side across the boiler. These drums are connected by a series of heavy tubes placed in one plane forming a water grate for the firing of the fuel. In using gas or oil as fuel or in stoker firing, the water grate with its drums may be eliminated providing ample room for stoker installation or large furnace volume for gas or oil firing.

Heating Pumps

Heating pumps have seen many developments in the last year or two and today offer a number of features which make for economy in operation and efficiency in performance. One of the most recent developments in pumps is represented by the new vapor turbine pump of Nash Engineering Co., South Norwalk, Conn. Driven by steam from the supply mains and returning it to the heating system, this pump eliminates the cost of electric current from its operating expense.

This unit is equipped with a vapor-turbine-driven pump with, as an additional safety measure, a complete electrically-operated stand-by unit with full automatic control by vacuum and float. The capacity of both pumps can be utilized under peak load conditions. The electrically-driven unit will automatically cut in at any time when the steam supply is insufficient to operate the turbine. The turbine is available if the current fails. The vapor turbine operates with any low-pressure vacuum-heating system.

The new Hoffman-Economy return-line vacuum pump, recently announced, has been simplified and changed based on a study of operating conditions, with the view of improving operation, quietness and ability. It now employs rectangular receivers of cast-iron construction, motors are of standard make, permitting quick replacement if necessary, and all pump parts are readily accessible. Under test, when starting a cold job, the pump recorded an air capacity of 160 per cent of rating. The initial condensate reaching the pump after exhaustion of air was removed at the rate of 300 per cent of rated capacity. Thereafter the removal of air and water was accomplished simultaneously. At 160-F water temperature and 6-in. vacuum, pump capacity for both air and water was 100 per cent. At 195 F and 3-in. vacuum, pump capacity was 85 per cent for air and 100 per cent for water, the ability to handle water at this temperature being due to a jet-type vacuum producer, according to the report.

A new type of vacuum-heating pump developed recently by Ames Pump Co., Inc., New York City, has several points of difference from previous models. It is a low-return pump; condensate from the system enters the low-return inlet on a level with the water storage chamber eliminating need for an accumulator tank and separate float chamber except in extreme cases where the return line comes in at a particularly low level. The motor and pump are mounted on a single shaft in a vertical assembly attached to the side of the receiver tank. By substituting a bellows lever arrangement at the float switch connection, packing at the float arm stuffing box has been eliminated.

Improved Condensation Meters

A new development in the field of condensation meters has been announced by the American District Steam Company, North Tonawanda, New York. A patented adjustable nozzle is now standard equipment with all of their rotary meters, which permits a fine adjustment of meter registration. This adjustable nozzle, by changing the angle of flow, corrects for any variation of meter registration due to fluctuations of spillage of the condensate into the buckets, or to the normal wear of meter parts in service. It is stated that with this new improvement in condensation meters, district heating companies and others are able to maintain their meters at high accuracy.

Clean Boilers

Maintaining clean heating boiler surfaces semi-automatically saves fuel and reduces the tendency for the job to be slighted. This is made possible by the soot blower of Diamond Power Specialty Corp., Detroit, Mich. It is available for both fire-tube and water-tube boilers. The system consists of a motor-driven air compressor, an air storage tank, a pressure-actuated switch and, for each boiler, one controller with switch, one electrical interrupter for timing the duration of each blow, one air control valve, the required number of soot blower units and connecting pipe, valves, fittings and wiring.

Deaeration

Most readers will recall the series of articles which appeared in the August, September and October (1932) issues of HEATING, PIPING AND AIR CONDITIONING on the corrosion of piping and deaeration. On page 673 of the October number, the authors of this series describe how the application of deaerators at Cornell University, Ithaca, N. Y., protect the return lines from deterioration by removing oxygen and carbon dioxide from the vacuum pump discharge.

New Types of Radiation

A NUMBER of new types of radiation and heat-transfer surface have been developed in recent months; as pointed out by Willis H. Carrier in his article in this issue, much study is being given methods of heat application and means of heat emission. Panel heating, which has been used extensively abroad, is finding increased use in this country and research on radiant heating is being conducted by a number of investigators.

Supplies Radiant and Convected Heat

A radiator which supplies both convected and radiated heat is illustrated in Fig. 18 (Shaw-Perkins Manufacturing Company, Pittsburgh, Pa.). It comprises an extended surface steel structure in contact with an internal copper tube which contains the heating medium,

either high- or low-pressure steam or hot water. The steel surface gives off heat by convection to the air circulating through the radiator and by radiation from the exterior surfaces. The radiator is available in a variety of arrangements—front or top air outlet grille, fully exposed on legs or wall brackets, or recessed. When recessed with front exposed it forms its own radiator, radiant front panel, enclosure and grille.

As the tube is protected by the exterior surfaces, high-temperature steam or water may be used as the heating medium; the radiators are tested for 150 lb working pressure.

Fin-Type Radiators of Cast-Iron

Finned radiators of cast-iron are now available; Fig. 19 shows one type (United States Radiator Corporation, Detroit, Mich.) made in depths of 3½, 5⅜, 7½, and 10⅝ in. and lengths from 18 to 63 in. in 5-in. steps. The fins are cast integrally with the fluid chamber and join together at their outer vertical edges forming the outer side walls of the radiator.

Concealed cast-iron radiators of the type shown in Fig. 20 (Crane Co., Chicago) are made in 18, 24 and 30-in. lengths. They can be assembled in single, double, or triple depths permitting considerable flexibility in installation. The waterways are amply large to afford heat storage capacity, aimed to provide better balance on systems using both concealed and standard radiators.

Concealed cast-iron convectors of fin construction have also been developed by The Unit Heater & Cooler Co., Wausau, Wis.

Built-in Fin-Type Heater

Fig. 21 shows a built-in heater of the fin type (Commodore Heaters Corporation, New York City). The header is designed with the idea of making it fit all standard types of valves and traps. The round metal legs attach to the headers and are threaded to permit adjustment.

Two "Modernizing" Types

A radiator which delivers 30 per cent radiated heat from its cast-iron front and 70 per cent convected heat produced by a copper convection heater within the unit is shown in Fig. 22 (Modine Manufacturing Company, Racine, Wis.). This radiator may be installed on the wall, partially recessed or completely recessed.

A pure convection type of radiator made by this same company consists of round seamless copper tubes press fitted into cast-iron tanks at each end. Copper fins are metallically bonded to the tubes. The header tanks are tapped top and bottom and are designed to accommodate the orifice type of valve.

Finned Pipe for Heat Transfer

Fig. 23 illustrates finned pipe (McCord Radiator & Mfg. Co., Detroit, Mich.) recently made available and adapted to use in concealed radiation, in refrigeration, cold storage, etc. The fins are copper or steel and are applied to galvanized iron, steel or copper pipe. The fins are wound on the pipe by stretching the outer portion of the ribbon.

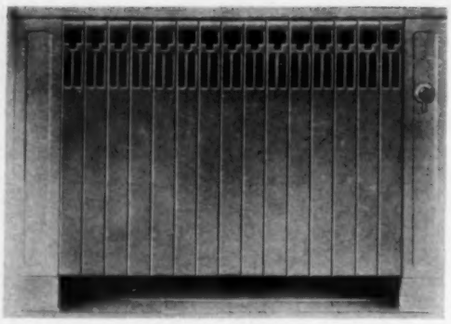


Fig. 18—Radiator which supplies both radiant and convected heat and available in a variety of arrangements

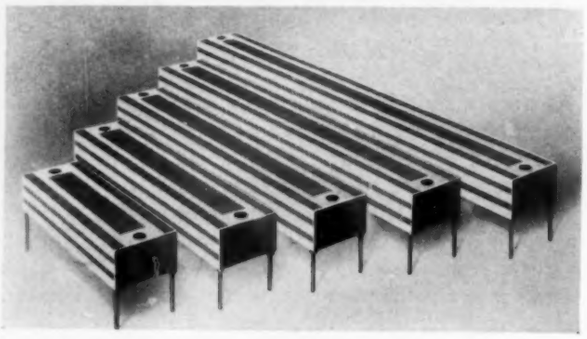


Fig. 19—Finned radiator of cast iron; the fins are cast integrally with the fluid chamber

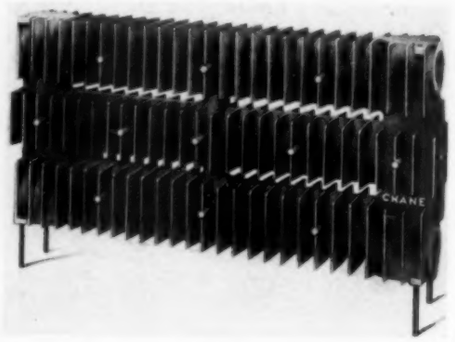


Fig. 20—Concealed cast-iron radiator in lengths to permit flexibility in installation. May be installed in single, double or triple depths

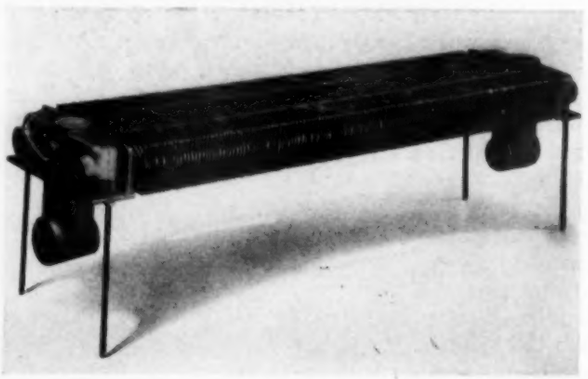


Fig. 21—Fin-type heater with header to fit standard makes of valves and traps

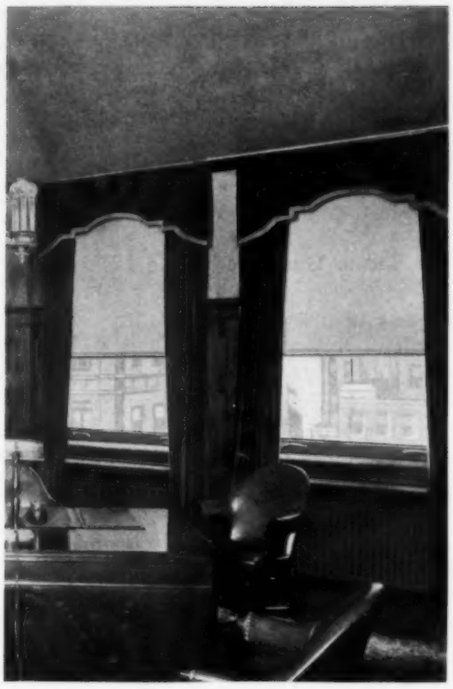


Fig. 22—This radiator has a cast-iron front and copper convection unit; it supplies 30 per cent radiated and 70 per cent convected heat

Fig. 23—Finned pipe for convection heating and refrigeration

A new and improved fan system heat surface was recently announced by Aerofin Corporation, Newark, N. J. It has flexible offset tubes, singlepass, header-to-header construction, high-temperature brazed tube joints for pressures from one to 200 lb and temperatures to 388 F New and improved booster units for heating or cooling were also announced.

Modernizing with Unit Heaters

UNIT heaters, while not new, are a recent heating development and improvement in the design of unit-heating equipment and the method of its application is constantly being made. It has been estimated by one engineer that 50 per cent of the heating systems in manufacturing plants could be modernized with the proper type of unit-heater system, *properly designed* and *properly installed*. This engineer quotes cases of such modernization giving returns of 20 per cent to 50 per cent—in extreme cases—on the investment, in addition to improved service.

Several representative types of unit heaters are illustrated here; complete design and application data are available from a number of manufacturers and should be referred to when the application of unit heaters to a plant or building is being studied. Control, the equipment for which may be had to suit practically any desired conditions, can be inexpensively provided and must be considered as a part of the system.

Units Modernize Machine Shop Heating

Fig. 24 shows a number of unit heaters (The Bishop & Babcock Sales Co., Cleveland, O.) installed along the center columns of a machine shop in Bridgeport, Conn. This installation was made as a modernizing project to correct certain difficulties experienced with the old heating system. Fifteen-thousand, five-hundred square feet of wall radiation were hung on the columns, and around the outer wall, as well as in the monitors. However, due to the great height of the building, as well as the distance above the floor of the radiators, the heating effect at the floor level was negligible, the cost excessive. With the exception of a few radiators at the end of the building, all radiation was removed and replaced by nineteen unit heaters, with a total capacity of less than the amount of direct radiation replaced. The installation was so successful that the following winter the superintendent stated his satisfaction with the heating results as well as with the economy effected. Despite the ceiling height and the frequent opening of doors no complaints are received of lack of heat at the working level, which were prevalent prior to this modernization.

No definite figures are available on the fuel saving, except that there was no increase in fuel consumption which, when it is considered that heating is now obtained

Fig. 24—Nineteen unit heaters in this machine shop replaced 15,500 sq ft of radiation which, because of the great height of the building, could not heat it properly

where it was not previously available may be figured as an actual saving.

The manufacturer of the unit heaters shown in Fig. 24 has recently developed a new unit with modernizing applications particularly in mind; with it, uniform temperatures are maintained either automatically through a thermostat or manually by a three-speed switch furnished as standard with the unit.

Turbine Drives New Unit

The new turbine-driven unit heater (Murray Iron Works Co., Inc., Burlington, Iowa) diagrammed in Fig. 25 is applicable to modernization of industrial heating systems. A principal feature is the saving in power cost; the steam drives the turbine and exhausts to the heater, where it is condensed at atmospheric pressure.

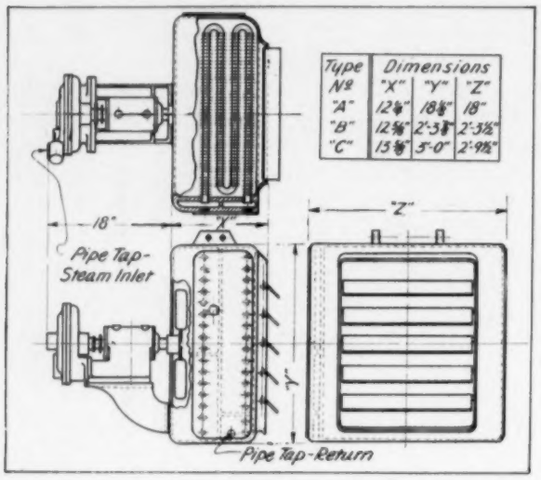


Fig. 25—A turbine-driven unit which may be used in modernization. As added steam consumption for driving the fan is about ½ per cent, the power cost may be said to be negligible

Control is by a thermostatic valve arranged to increase and decrease steam flow to the turbine, thus changing the heat admitted and the air flow from the fan. Endeavor is made in installing the units to arrange for ⅔ of the steam required by the heater in mildest weather to be used for driving the turbine, ⅓ being bypassed through a needle valve; in colder weather the bypass valve opens further. Full load speed of the turbine is generally about 1,200 rpm, but where some noise is allowable this may be 1,800.

Three Gas-Fired Unit Heaters

A gas-fired unit which has recently been announced (Thermidaire Division, E. K. Campbell Companies, Kansas City, Mo.) is shown in Fig. 26. The heat-exchanging element consists of large staggered copper tubes, brazed into 48-oz copper headers. The gas burner consists of a number of tubes each with its own orifice mixer to promote perfect mixtures at the tip. Complete controls and down draft diverter and draft hood are provided. Capacities range from 60,000 to 500,000 Btu input, fan sizes from 12 to 26 in.

A suspended-type gas-fired unit (F. O. Schoedinger, Columbus, O.) especially designed for heating small stores and similar areas has cast-iron surface with only two joints. According to the manufacturer, standby temperature is a feature enabling quick delivery of heat.

A gas-fired unit for heating large spaces such as assembly halls, factories, warehouses, airplane hangars, garages and similar areas is illustrated in Fig. 27 (Surface Combustion Corporation, Toledo, O.). Its hourly Btu input is 200,000 and it will burn either natural, manufactured or mixed gas. The heating element of chrome steel alloy metal is designed to be corrosion and temperature resistant. The tubes are streamline to promote heat transfer and reduce resistance to air flow. This company has recently announced a small portable

Fig. 26 (left)—New gas-fired unit heater which may be had in Btu inputs from 60,000 to 500,000. Fig. 27 (center)—Gas-fired unit with hourly Btu input of 200,000 which burns either manufactured, natural or mixed gas. Fig. 28 (right)—This electric-type unit has a non-glow coil; its capacity is 1 cu ft of air to each 15 watts heater capacity

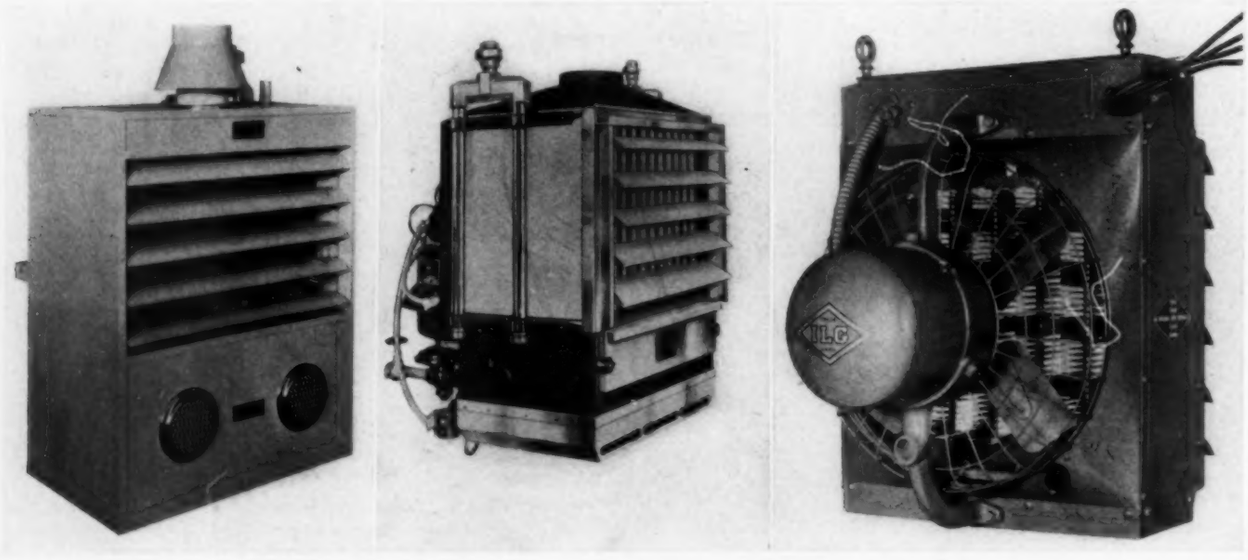


Fig. 29 (circle) — Unit which can be used for heating or cooling installed in an office

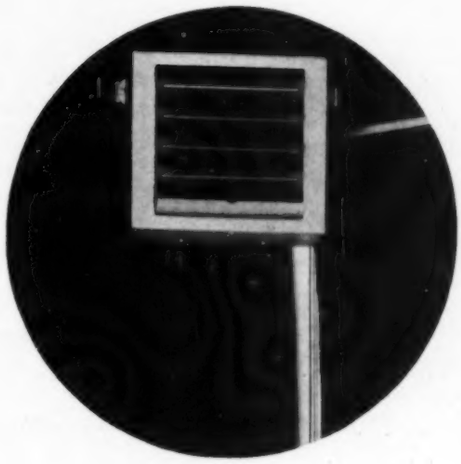


Fig. 30 (above)—This heating or cooling unit has an air blanket bypass around the heat-transfer surface to prevent condensation on the exterior

gas-fired fan-circulating warm-air heater for isolated offices in warehouses, factories, and such places.

An Electric-Type Heater

As explained in a previous issue, electricity may often be used to advantage for heating. The unit (Ilg Electric Ventilating Co., Chicago) shown in Fig. 28 is an electric-type which can be used in modernization work. The coil is of a non-glow type protected by an automatic thermal cut-out. The unit has a capacity of 1 cu ft of air to each 15 watts of heater capacity to insure low leaving air temperatures. It is available in twenty different sizes and capacities ranging from 1½ to 60 kw.

These Units Heat or Cool

A unit which may be used for heating in winter and cooling in summer (The McCord Radiator and Mfg. Co., Detroit, Mich.) is shown installed in an office in Fig. 29. In new buildings, this unit may be built into the wall.

For heating, hot water is circulated through the cellular copper radiator core. Cold water (mechanical refrigeration, ice, or tap water) is used in summer.

Also for either heating or cooling is the unit shown in Fig. 30 (B. F. Sturtevant Company, Inc., Boston, Mass.). It is made in five sizes ranging in air delivery from 450 to 3,000 cfm and complete capacity tables and ratings are available. An air-blanket bypass around the heat-transfer surface prevents condensation on the outside of the unit in summer.

A cooling and heating unit (American Blower Corp., Detroit, Mich.) for offices, stores, restaurants, shops, etc., is illustrated in Fig. 31. It consists of a dual purpose coil of special design through which hot water in winter and cold water in summer is circulated. A three-speed switch controls the volume of air, which is circulated by a multiblade fan. Installation of the unit may be made in one or a number of offices in a building.

Stresses "Spotting" of Units

In applying its unit heaters, Modine Manufacturing Company, Racine, Wis., stresses the "spotting" of units. In general, this manufacturer states, the units should be placed to give a circular movement of air in the building. To do this the units are placed in tandem, so that the air movement from a unit 50 to 100 ft from the rear of a second unit will assist this second unit to throw its delivered air a greater distance. In applying this principle there should be kept in mind the importance of avoiding short-circuiting of air from one unit to another.

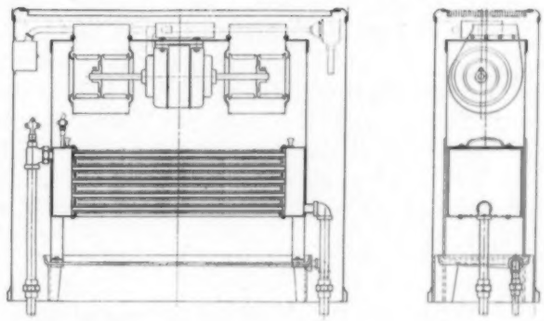


Fig. 31—Heating or cooling unit which may be installed in one or a number of offices in a building

Use of Two-Speed Heaters

The application of the unit heaters made by The Herman Nelson Corporation, Moline, Ill., are numerous because of the range of sizes available and because one- or two-speed heaters may be had. One-speed heaters are used in factories, workshops, foundries, garages, etc. The two-speed heaters are used where quieter operation is required, such as in stores, factory offices, gymnasiums, and the like. In such cases, heaters with sufficient capacity to heat the space properly on slow-speed operation are selected, the high speed being used to heat the room quickly prior to occupancy.

Piping Developments are Numerous

PIPING is the most important transportation system of industry. Instead of conveying goods, machinery and a variety of products, it conveys steam for power, process and heating uses, water, air, oil, gas, refrigerants, process liquids of all kinds, solids and semi-solids.

Transportation is a matter of getting anything somewhere at the least possible cost. In the industrial transportation field, as represented by a piping system, the freight or express rates are paid in the boiler house or pumping station and not distributed over the piping lines that in reality have so great a bearing on the tariff. The F. O. B. of rail transportation can not be duplicated in industrial piping transportation lines. The man who ships heat or energy from a boiler to a machine through a pipe line pays the freight at every fitting, joint and bend. He pays for obsolescence, maintenance and depreciation. Let him look, therefore, to his plant's piping systems for modernization opportunities.

In the following pages the engineer will find a review of a number of types and makes of piping equipment, including pipe itself, flow meters, pipe covering, welding and welding fittings, steam traps, supports and expansion joints, pumps and valves. It is not the purpose to show all such equipment available; rather, it is to show representative types and to suggest particularly how improved, modern devices can be utilized by the engineer to keep the "tariff" of his industrial piping systems at a rate in line with present operating and production requirements.

Flow Meters and Modernization

JUST as in the case of the family budget the first thing to do before trying to "stop the leaks" is to determine where the money is going, so in reducing operating and production costs in plants and buildings the first thing to determine is exactly what makes up these costs. An engineer can not improve conditions until he knows definitely what the conditions are. Hence, the place of flow meters in modernizing heating, piping and air-conditioning systems for economy and profit.

Generally speaking every six pounds of steam wasted equals one pound of coal wasted, in addition to the cost of water, labor, general supplies and equipment. Obviously it pays to know where every pound of steam goes and how economically it is used. Flow meters installed on departmental steam lines furnish records for studying steam distribution from which the engineer can obtain the facts to guide him to changes, replacements and additions which will provide for more economical consumption of this valuable product. Similarly, the measurement of process liquids, water, oil, gas, air, etc., will provide invaluable information on costs from which opportunities for saving can be determined.

Paper Mill Checks What Becomes of Full Steam Supply

In Fig. 1 is shown the installation of nineteen recording and totalizing meters (Republic Flow Meters Co., Chicago, Ill.) at the Champion Fibre Co., Canton, N. C. The power costs in a paper mill are approximately 25 per cent of the total conversion costs and in almost any pulp and paper mill operating without instruments it is claimed a 12- to 13-per cent reduction in the cost of power can be effected. A 12- to 13-per cent cut in

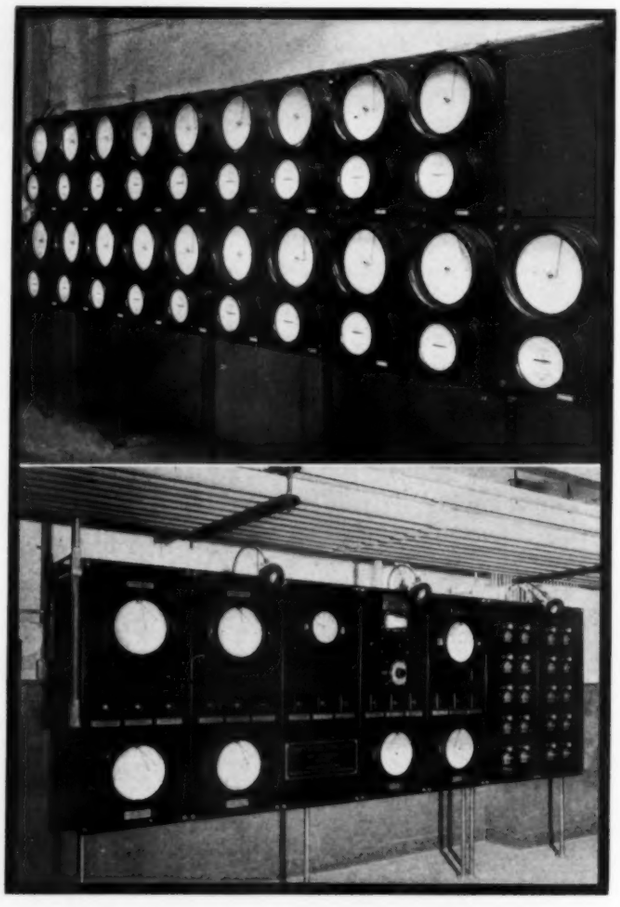


Fig. 1 (above) — Nineteen recording and totalizing meters show Champion Fibre Co., Canton, N. C., what becomes of the full steam supply when it leaves the boiler room

Fig. 2 (below)—In the Chrysler Building the chief engineer can easily check his instrument board to see that his heating, air conditioning and hot-water systems are functioning satisfactorily

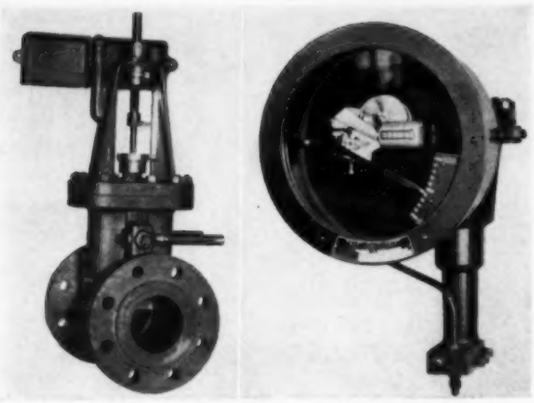


Fig. 3 (left)—Adjustable orifice for use with fluid meters measuring gas or low-pressure heating steam where measurements must be made over a wide range of capacities

Fig. 4 (right)—Indicating and integrating flow meter which meets requirements in those cases where steam is sold on the basis of meter readings and a continuous record of the rate of flow is not desired

power costs means an increase of about 20 per cent in profits. By the cost of power is meant, of course, the cost of the steam employed in process operations as well as that of the steam to turbines and steam engines.

The first requisite for reducing power costs, therefore, is the acquisition of knowledge concerning what becomes of the full steam supply when it leaves the boiler room, and what it accomplishes in the way of useful work before it condenses. This flow meter installation at Champion Fibre Co. plant gives the following information:

Output of each boiler; total output of boilers; steam to sulphite digesters; steam to soda-sulphate digesters; steam to pulp dryers; steam to pulp dryer engines; steam to liquor making rooms; steam to soda-sulphate bleach rooms; steam to sulphite bleach rooms; steam to extract department; steam to paper mill dryers; steam to pulp machine engines.

The value of such data is obvious to any engineer concerned with the distribution of steam.

Building Controls and Registers Its Heating and Air Conditioning Services

In the chief engineer's office of the Chrysler building, New York City, heat, water and air conditioning are controlled and registered as they are distributed throughout the building. The chief engineer by checking his instrument board can readily see that the different systems are working satisfactorily. In Fig. 2 is an illustration of the instrument panel board in this building (Brown Instrument Co., Philadelphia, Pa.).

Steam flow meters inform the engineer just where the steam is being used and to whom the cost will be charged. An indicating resistance thermometer enables him to check the air conditioning and ventilating system. This equipment gives wet bulb temperature for humidity after the air has been reconditioned. A recording pressure gage is used on all steam lines, following the reducing valve and when a valve fails to function the engineer is notified by an automatic alarm and can easily adjust the trouble.

Hot water in a structure such as the Chrysler building is kept at a certain temperature always. The temperature control is automatic and registers on a recording thermometer. Here also an alarm device is employed to control, so to speak, functioning of this system. It matters not in which part of the building trouble occurs, the chief engineer needs only to look at his instrument board to locate it.

For Measuring Low-Pressure Heating Steam

An adjustable orifice and a fluid meter (Bailey Meter Co., Cleveland, Ohio) have recently been developed which apply particularly well to the heating field. In Fig. 3 is shown the adjustable orifice; in Fig. 4 is shown the fluid meter.

The adjustable orifice is particularly suitable for use with fluid meters measuring gas or low pressure heating steam, since on these services measurements must be made over a wide range of capacities, as the desired capacity is often dependent upon the season. It consists of a flanged body with integral meter connections. It can be readily installed in a steam, water or gas line and connected to any differential head type of fluid meter. A micrometer adjusting screw permits setting the height of the gate segment within 0.001 of an inch. When it is advisable to change the capacity of the meter, it is simply necessary to set the micrometer screw at the reading corresponding to the desired maximum capacity, as obtained from curve sheets furnished with the orifice. It permits changing the maximum capacity of the meter as much as 40 to 1 and consequently is equivalent to a multitude of fixed orifices. The change may be made in a few minutes' time without disrupting meter operation or diverting the flow through a bypass line.

The meter illustrated is designed to meet those cases where steam is sold on the basis of meter readings and a continuous record of the rate of flow is not desired. The operating mechanism consists of a mercury-sealed bell the same as used in the standard recording fluid meter; but the chart plate, chart, recording pen and large meter casing have been omitted.

Recent Valve Developments

VALVES are one of the most important items in a piping system and the selection of the proper valve for the service required is a matter which should be given particular attention in modernizing industrial piping systems. One of the leading authorities describes a valve, in part, as "any of the numerous devices by which the flow of liquid, air or other gas, loose material in bulk, etc., may be started, stopped or regulated by a movable part which opens, shuts or partially obstructs one or more parts or passageways." Under this head come the standard globe, angle and gate valves, familiar to all piping engineers, as well as various types of valves to meet special requirements, including motor-operated and solenoid valves.

New Line of Motorized Valves

The motorized valves shown in Fig. 5*a* and *b* represent a complete line now offered by Fisher Governor Co., Marshalltown, Ia., for practically all services. They can

be operated by any number of types of remote switching devices, such as thermostatic switches, hand-operated switches, clock switches and others. The valve shown at *a* is made only in the smaller sizes, up to and including 3-in. It utilizes a direct-operating motor, acting directly on the valve stem. This unit is single-seated and can close off tight on dead-end service.

The valve *b* (Fig. 5) is made in all sizes up to and including 10-in. It uses a double-seated valve body which can be furnished in either cast iron or steel, with duromite bronze, monel metal or stainless-steel trimming. The main valve itself has a rotary stem and ball-bearing stuffing box, and the motor can be furnished to operate in either open or closed position, throttling or snap-acting. Motors are available for a number of different currents.

An industrial plant recently installed some of this motorized equipment where it had water tanks and process controls in one building that had to be operated about every ten or fifteen minutes at exactly the correct time from another building. Heretofore this had been done through a manual control system that gave some trouble and usually required about one man's time to keep in operation. The installation of the motorized equipment eliminated the cost of this labor on the old system and it was estimated that the new system would pay for itself in a short time.

This company has also announced a new development in its pressure-reducing valve, illustrated at *c* in Fig. 5. The view shows the swing link yoke which has improved the operation and life of this regulator. With this device the bending action of the stem is eliminated, and the guiding action makes more sensitive operation possible and enables the packing gland to hold tight with little friction. With this yoke construction the regulator may be installed with the diaphragm above the pipe line if there is sufficient head room, or in case the pipe line runs close to the ceiling the regulator can be easily converted to operate in the inverted position with the diaphragm below the pipe line by simply changing the lever from one side of the yoke to the other.

Several well-known manufacturers make motor-operated valves. Features which General Electric Co. stress about its thrustor valves include operation from a remote point, smooth operation eliminates impact of valve parts, maintenance is negligible, sliding or wearing parts are the minimum, operation from normally open to normally closed is easy to change in the field, motors can not be overloaded and consume little power, operation makes for control simplicity.

Three-Way Valves for Process

In a pilot controlled regulating valve lately introduced by the Cochrane Corporation, Philadelphia, a pilot actuated by a float or other primary control admits the supply pressure to a hydraulic piston, which follows up and moves with the pilot, thus avoiding over-travel and hunting. Both the main valve and the pilot valve are single seated and close with, and are held tightly to seat by, the pressure. As the pressure of the liquid which is being controlled is utilized for the operation of the valve, no auxiliary operating fluid is required. This is illustrated in Fig. 5 (*d*).

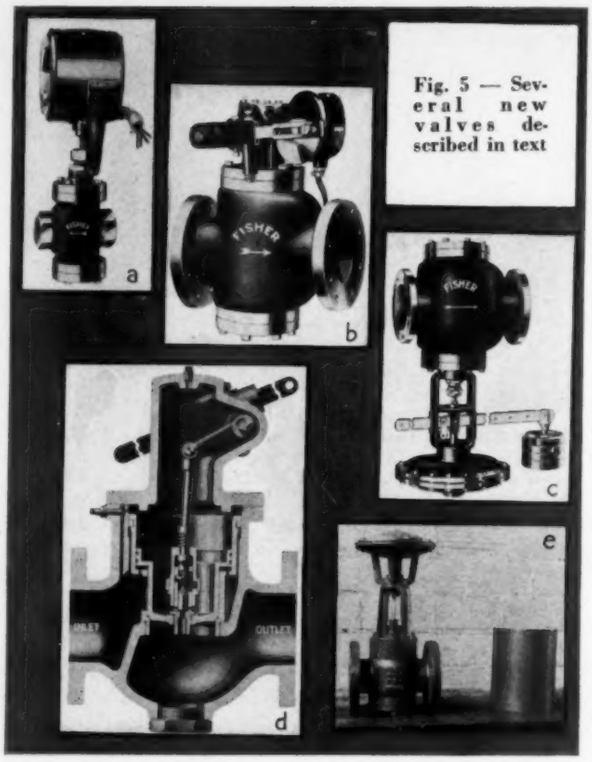


Fig. 5 — Several new valves described in text

New Air-Actuated Valve

At *e* (Fig. 5) is shown an improved type diaphragm valve manufactured by Shand and Jurs Company, Berkeley, Calif. The diaphragm has been extended and away from the body of the valve, which prevents communication of heat, particularly on high-temperature installations. The bearing which contains the spring and provides change of tension by merely screwing clockwise or counterclockwise, contains a frictionless bearing for the shaft. The gland is of a new type known as the lantern gland, and provides ample space for greasing and maintaining grease through an alemite fitting or other means, which is communicated through an opening on the outside edge of the gland yoke. The diaphragm housing and gland yoke are screwed together, making a very sturdy unit, protection of which permits of using a smaller diameter shaft, thus reducing friction to a minimum. The whole upper structure of the valve may be covered by sheet metal casing which is easily removed by loosening two screws. The valve can be made either reverse or direct acting by merely taking the bottom cover completely off, taking the top yoke off and placing it on bottom.

Diaphragm Valves Are Rubber Lined

A new diaphragm valve made by Hills-McCanna Co., Chicago, Ill., is hard or soft rubber lined (American Hard Rubber Co., New York, N. Y.). The hard-rubber-lined valve is recommended for practically all corrosive work. The soft-rubber-lined valve is suitable where abrasion is a factor. There is no stuffing box to leak and the diaphragm is supported in all positions. The working mechanism of the valve is segregated from the corrosive solution handled. This valve is now available

in sizes from 1 to 4-in. inclusive. The manufacturer is considering adding to the line up to 14-in.

For use with Mueller Brass Co.'s (Port Huron, Mich.) streamline copper pipe the Scott Valve Mfg. Co., Detroit, Mich., offers radiator valves, gates, globes, angles, swing checks, sill cocks, drain gates, compression stops and wastes, union ells, service gates and curb cocks.

Solenoid-operated valves made in two, three and four-way types have been developed by W. H. Nicholson Co., Wilkes-Barre, Pa., for use on air, steam, oil, water, gas, etc. lines. Where it is desired to operate single- or double-acting cylinders by remote control, through a push-button station or automatic time cycle device these valves are available for 110, 220, 440 or 550 volts, a-c or d-c currents. This same company has announced a foot-operated valve in two, three and four-way types for use on air, steam, oil, water and gas lines.

The multi-valve of Ludlow Valve Mfg. Co., Troy, N. Y., incorporates in its design all the features essential to its performance as a blow-off valve, a throttle valve, a drain valve and a stop valve—in other words, it is a universal valve for power and process lines.

A new line of rising stem bronze gate valves for 125-lb steam pressure and 175-lb water pressure has been made available by Kennedy Valve Mfg. Co., Elmira, N. Y. A flexible connection is provided between the disc and the stem so that the stem will not bind or spring when the valve is closed. The stem is made of a bronze composition of high tensile and torsional strength, and has a large number of contact threads in the bonnet.

Recommended for services where high strength and close control are desirable are the ¾- and 1-in. globe valves which are an addition to the Reading-Pratt & Cady Company, Inc. (Bridgeport, Conn.), line of bar stock valves. The valves are precision turned from carbon steel and have stainless steel, slip-on renewable discs and stainless steel screw-in seats. Stems are designed and treated for temperature service and all other parts are protected against corrosion.

Design of a plug type lubricated valve has been improved by the American Car and Foundry Company, New York City, and it is now manufactured with a solid head construction to avoid the use of glands, gland bolts, bonnets or stuffing boxes; no packing or gaskets are employed. The valve opens and closes with a quarter turn against a positive stop; there are no seats. The face-to-face dimensions of the flanged valves are the same as standard gate valves.

Improvements in Traps

CONDENSATE forming in steam lines may seriously damage, if not totally wreck, engines and turbines, while water hammer may seriously affect piping and equipment. Condensate remaining in heating coils and the like will not only cut down the volume of steam and heat transfer efficiency but also damage the coil or steam-heated machine. Hence, the steam trap—to remove condensate without loss of steam.

While a leaky trap will keep a line drained, it will also waste a lot of steam. Assuming a steam cost of 50 cents per thousand pounds at 100-lb pressure, a ⅛-in. diameter leak will cost $30.30 per month. Therefore, steam traps must be kept in first-class mechanical condition with steam-tight valves in order to insure safe and economical operation of steam lines or steam-heated machines. They represent a very important item in any modernization program.

Trend Toward Smaller Traps

Recent developments in steam-trap design indicate a trend toward smaller traps to drain units individually.

In Fig. 6 is shown part of an installation of 57 inverted open-float steam traps on paper-machine dryers in a Green Bay, Wis., paper mill. These traps (Crane Co., Chicago) have been designed to meet the demand for a small, inexpensive but efficient trap. The inlet is at the bottom. Condensation flows upward into the body of the trap. Since the valve is at the top, the body of the trap must be full of water before any condensate can be discharged. The discharge is continuous until no more condensation enters the trap. Steam then enters the float and displaces the water contained therein to a point where the float becomes buoyant and rises. This closes the valve and stops further discharge. The float remains buoyant until condensation enters and replaces the steam. The float then sinks and opens the valve.

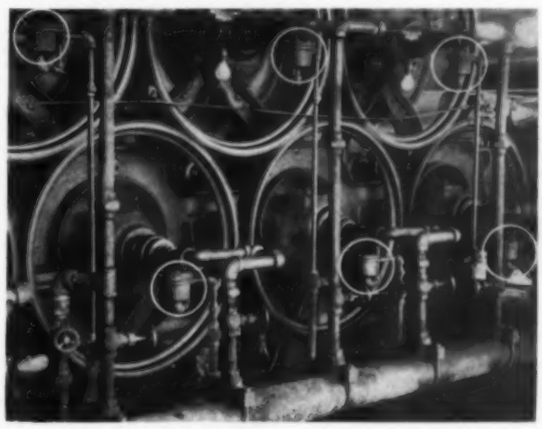


Fig. 6—Fifty-seven inverted open-float steam traps, of which those illustrated are a part, remove condensation without waste of steam from paper machine dryers

High capacity is a feature of an improved line of steam traps lately developed and utilizing the inverted bucket principle (Armstrong Machine Works, Three Rivers, Mich.). Wearing parts are of stainless steel.

These traps are furnished in cast semi-steel for pressures up to 250 lb. In the forged steel pattern, the traps are available for 600, 900 and 1,500 lb pressure with any degree of superheat.

In the new inverted bucket trap of the Swartwout Co., Cleveland, Ohio, the body is substantially full of water during operation at all times. Air escapes through a small vent in the top of the bucket and collects in the top of the trap ready to go out in the next discharge. Steam also escapes through this vent condensing in the water above the bucket. As the air and steam is

replaced in the bucket by water the bucket loses its buoyancy.

An addition to its line of steam traps has been announced by the V. D. Anderson Company, Cleveland, Ohio. The trap is light in weight and small in size; it requires little space for pipe connections thereby making it particularly applicable for use on small steam-using units. The trap can be furnished chrome plated and highly polished.

In the matter of modernization, Strong Carlisle & Hammond Co., Cleveland Ohio, manufacturer of the recently developed bucket traps and anti-balancing device for traps described below, finds there has been a distinct trend throughout the industrial field to improve the quality and uniformity of products. As an illustration, this company cites a leather manufacturing concern which rebuilt its drying ovens. The existing equipment had been in operation for many years and, while it operated reasonably satisfactorily, the company had difficulty in producing a uniform product.

This company had a variety of sizes and shapes of ovens which had been built as the capacity of the plant increased over a period of years, and no two of them were alike. The rebuilt plant does not reduce labor cost but does enable this concern to control temperatures and get a higher price for its product. Instead of reducing costs it increases the sales value of the product and this additional income or a portion of it can be passed on to employes, who are paid on a bonus system.

The new inverted bucket traps, recently introduced by Strong, Carlisle & Hammond Co., embody several improvements in design and materials. Both use an anti-balancing device, consisting of a valve arrangement which replaces the air vent hole in the bucket.

The anti-balancing device consists of a valve arrangement in the lever which replaces the air vent in the bucket. The valve has a small opening at all times to allow the air and other gases to escape from the bucket while the trap is filling. When the trap reaches the point of discharge, the larger valve is opened automatically, allowing a quantity of air to escape quickly from the bucket and sufficient water to enter the bucket. This overbalances the bucket and opens the main trap discharge valve.

Applicable to risers, small mains, unit heaters, etc., the new float trap made by the Sarco Co., Inc., New York City, has an integral thermostatic air bypass inside the trap. All the working parts are mounted on the cover and are exposed for service by removing the trap cover.

For keeping risers, steam mains, unit heaters and similar apparatus free of condensate and air, a drip trap has recently been developed by Hoffman Specialty Co., Inc., Waterbury, Conn., which is designed to combine large capacity and compactness. A feature of the trap is a double-seated valve which is balanced against steam pressure; the upper valve closes with steam pressure and the lower valve against steam pressure. Initial and entrained air is vented directly to the return through a by-pass controlled by a thermostatic element.

In the new trap of Justus Steam Trap Co., Napanoch, N. Y., the discharge valve is a regular angle valve adapted for automatic control and of the same capacity as is the inlet of the trap. The float does not operate the discharge valve but controls the pressure to a diaphragm and makes this pressure do the real work of operating the discharge valve. The trap is equipped with a high-pressure air valve especially designed to clear the lines of all air. There are no packed glands or close fitting moving parts. Every working part except the float valve is on the outside of the trap and readily accessible.

A pumping trap has been developed by Bundy Steam Trap Co., Nashua, N. H., to handle condensation from exhaust or low-pressure systems and discharge it to a desired point. The system is adaptable for handling water of condensation from coils or condensing surface located at a distance from the boiler room. Traps in service are forcing water 2,000 ft and more under this application. This three-valve pumping trap has a fixed discharge valve actuated by the movement of the bowl. When the bowl fills with water it settles down in the ring and this movement opens the discharge valve and the operating valve at the same time. When the water is discharged the bowl returns to its original position and closes both the discharge valve and steam operating valve and opens the vent valve.

The features stressed in the modernized inverted bucket steam trap of Kaye & MacDonald, Inc., West Orange, N. J., are only one moving part, frictionless compound rocking fulcrums on a single lever, no fixed pivots, side inlet and outlet, no cooling leg required, no mechanism attached to cover, no cored water passage to retard capacity, large size valve and full opening.

The majority of these traps described in the foregoing have been illustrated in recent issues of HEATING, PIPING AND AIR CONDITIONING.

Welding and Welding Fittings

PROPER design of a piping system involves a great many considerations which must be weighed in proper relation to their respective importance on a particular job. First cost is an important consideration but not the only important one. Strength and efficiency, maintenance and replacement costs, general bulk and weight of the materials in relation to space available, the possibility of making installations quickly and, at the same time, in a first-class manner are a few of the items that should be given careful thought. In present day piping practice appearance is also an important consideration.

Pipe welding has met these factors of design, installation and maintenance and is playing an important part in the fabrication of modern piping systems and in the modernizing of old piping systems. Equipment, both acetylene and electric, has been developed and improved in the last two or three years, satisfactory welding rod and electrodes for the particular problems involved in pipe welding have been prepared, special fittings for welding installations have been produced, welding practices both in the shop and in the field have been studied in the light of experience and perfected to a practical degree.

New Portable Pipe Cutting and Beveling Machine

One of welding's most recent developments is shown in *a*, Fig. 7, a new portable pipe cutting and beveling

machine in operation (Air Reduction Sales Co., New York, N. Y.). This new machine comprises a light four wheel carriage on which are mounted a crank-driven chain sprocket and a torch supporting bracket. The carriage is held against the pipe by a roller chain surrounding the pipe and engaging the sprocket. The latter supported by coil springs reacts on the chain and when turned by the hand crank develops sufficient frictional grip to rotate the pipe when the latter is free to turn, or to rotate the machine itself around the pipe when the pipe is fixed in position.

The machine cutting torch is adjustable on the bracket to any required bevel angle from vertical for cutting off square, to 45 degrees, more or less, for any welding bevel required. The torch may also be adjusted laterally to produce a lead cutting angle which is found necessary on bevels for clean cuts free of slag. This angle varies slightly with the pipe diameter and wall thickness.

In reconditioning old pipe lines this machine can be fitted with two cutting torches set oppositely for cutting out couplings and threads and beveling both ends for welding in one operation.

Further adaptability of this machine to pipe preparation for welding is illustrated by fabrication for a 90-degree welded branch or tee. The vee-shaped end of the branch is cut following a layout line made with a pipe templet. The torch is racked back and forth along the horizontal bar while the cut progresses.

Other pipe fabrication, such as two-, three- or multiple-piece ells, wyes, reducers and bull nose closures; also pipe clotting for gravel screens, and coupon cutting for weld tests, are uses to which this machine is adapted.

Blowpipe for Pipe-Line Work

A welding blowpipe primarily for use on pipe-line work, but not restricted to that field, is a fairly recent development of Linde Air Products Co., New York City.

Oxygen and acetylene valves are located on the front of the handle, so that flame adjustments may be made readily while the blowpipe is in operation. The acetylene valve is located on the left side of the front of the handle where the operator's right thumb can conveniently regulate it. The oxygen valve is on the under side of the handle; this arrangement makes it unneces-

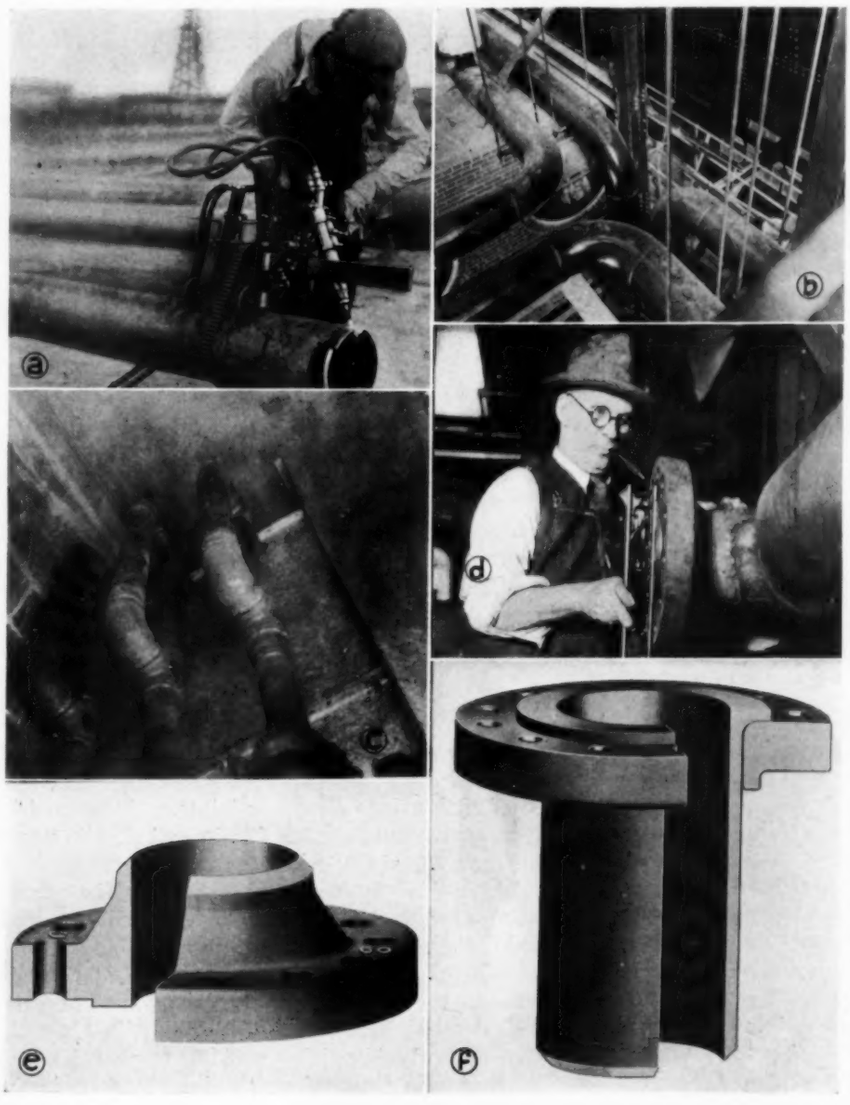


Fig. 7*a*—Pipe welding developed the need for this portable machine to cut off and bevel pipe to the desired welding angle. *b*.—The power plant of the Hudson River State Hospital at Poughkeepsie, N. Y., fabricated its piping with 12-in. extra heavy welding elbows in single vee-type welded joints. Note that hangers are lighter than usual due to reduced weight of the welded job. *c*.—Welding ells, tees and reducing nipples in steam connection to coils. All fittings are of seamless construction. The ends are machine-tool beveled for welding. Elbows have short tangents to facilitate easy alignment. *d*.—Making a difficult installation of a branch easy by using a tee joint welding fitting. All of the welding on this job was done with the main pipe in position. The fitting was used to connect a 6-in. water regulator line into an existing 8-inch. boiler feed line. The welder has his square on the face of the welding neck flange to show that there was no distortion or warping. *e and f*—Welding neck flange and lap welding nipple with lap flange

sary for the operator to use his left hand, which is holding the welding rod, to adjust the blowpipe valves.

Announcement of a line of general-purpose welding rods comes from The Champion Rivet Company of Cleveland, Ohio. Featured is a heavy flux-coated rod to produce welds from 60,000 to 70,000 lb tensile strength with an elongation in excess of 35 per cent in 2 in. A general-purpose rod with a powder coating and two types of light-coated rods for special applications—overhead and vertical welding, for instance—have also been announced.

Arc Welders

Arc welders have come into the pipe field and have many records of successful installations in large buildings and industrial plants. General Electric Company's arc welder features a stable, flexible arc, quick recovery, self-excitation, spark-free commutation, simple operation, duplex voltage control, dead-front control panel, large, protected instruments, light, compact, strong construction and low center of gravity. This company developed during the year a "heavily coated" electrode primarily for overhead and vertical welding by hand, as on position welds in pipe line construction.

A new engine-driven, 300-ampere arc welder of the high speed portable trailer type, using a shunt induction principle for arc stabilization aimed to permit high efficiency, greater metal deposit and little operator fatigue, is a development of Universal Power Corp., Cleveland, Ohio.

Dual control for close regulation of the welding heat, separate excitation for quick recovery, reverse polarity switch for changing leads and use of a rubber mounting to eliminate vibration are among the features of a new arc welder (Imperial Electric Co., Akron, Ohio) in sizes from 100 to 800 amperes in motor-, gas-engine-, and belt-drive types.

A new magnetic bridge and a short-circuit winding have extended the welding range and improved arc recovery and stability in the arc welder of Harnischfeger Corporation, Milwaukee, Wis. The new dead-front control cabinet adds to the general appearance of the unit and further simplifies the design. Voltmeter, ammeter, etc., are contained in the single cabinet.

Arc welders with features particularly suitable for pipe welding work also are available from such manufacturers as Westinghouse Electric & Mfg. Co., Lincoln Electric Co. and others.

Welding Fittings

The development of all kinds of fittings for use with welded piping installations, featuring savings in time and layout of installations as well as strength of joint, is shown in accompanying illustrations.

Fig. *7b* shows an installation of the welding elbows manufactured by Tube-Turns, Inc., Louisville, Ky. Fig. *7c* illustrates an application of welding ells, tees and reducing nipples, the products of Taylor Forge & Pipe Works, Chicago, Ill. Fig. *7d* shows how a branch line was connected into an existing line by means of the tee joint welding fitting of Bonney Forge & Tool Works, Allentown, Pa. Figs. *7e* and *f* show two welding fittings made by Crane Co., Chicago, Ill. Welding ells, Van Stone welding nipples, welding reducers, welding flanges, shaped welding nipples, welding heads, welding sleeves and welding saddles comprise the line Midwest Piping & Supply Co., Inc., St. Louis, Mo., has developed.

The Taylor fittings may be had in A. M. Byers Company wrought iron.

Supports and Expansion

As A. W. Moulder, Grinnell Co., points out in his article in this issue, "Industrial Piping Pays Modernization Dividends," a factor which probably contributes to interior corrosion as well as wear and tear of a piping system to a greater extent than is generally realized is the proper supporting of piping when it is installed plus the need for thereafter keeping it in proper pitch and alignment. Pockets or low spots in piping—not only with steam but with air and gases—will cause greatly increased corrosive activity at these points. These pockets are often caused by improper types of supports which allow the piping to sag or by not making provision for adjustment to compensate for settling of the structure from which the piping is supported.

Fig. 8—Packless expansion joint available for 125-lb and 250-lb steam pressures and superheat, with standard flanged or beveled ends and for any length of traverse

Other causes of deterioration and wear and tear are inadequate provision for expansion and contraction or suitable hangers to allow for vibration.

The engineer, therefore, can well consider replacements of or additions to his piping system's supports or hangers and expansion joints as possible steps to take for saving on upkeep and maintenance of pipe lines.

Supports and hangers to meet every possible condition of pipe installation are available from manufacturers. Articles have appeared in Heating, Piping and Air Conditioning to which the reader can refer for types of supports and their place in proper design, installation and maintenance of piping.

This is true, also, of expansion joints. Developments during the year of three manufacturers of expansion joints, however, can be briefly summarized here:

The packless expansion joint manufactured by American District Steam Company, North Tonawanda, N. Y., has been improved by the use of special stainless alloy steel diaphragms, high tensile strength alloy steel stud bolts and design and permits of accommodating longer traverse of a pipe line. The new joints, as illustrated in Fig. 8, are now available for 125-lb and 250-lb steam pressures and superheat, with standard flanged or beveled ends and for any length of traverse. The use of the special alloy steel diaphragm is designed to remove the hazard of crystallization or deterioration due to vibration, sustained high temperatures, or frequent flexings and increases the flexibility of the joint.

The Yarnall-Waring Co., Philadelphia, Pa., has developed a method of applying packing to an expansion joint which does not necessitate turning off steam in the

line being packed, but can be accomplished through the application of plastic packing.

The principle of pressure lubrication is used with this company's cylinder guided expansion joint. This is accomplished by tightening screw-pressure guns in a cylinder built into the packing gland. These guns force a semi-solid fibrous packing into the stuffing box. This was described in detail in the November issue of HEATING, PIPING AND AIR CONDITIONING.

A packless expansion joint for use with hot-water heating system lines, service water lines or any service where it is desirable to allow for expansion of liquid carrying lines has recently been developed by Fulton Sylphon Co., Knoxville, Tenn. Featured is the possibility of simplifying building plans, reducing construction costs and saving valuable space through the use of this factory-assembled unit which comes to the job ready for installation as simply as any other single pipe fitting. After being properly installed the joint will absorb 1¼-in. expansion and will allow for ¼-in. contraction of the pipe line. It is designed to carry liquid pressures up to 150 lb per sq in.

Piping Materials

DETERIORATION of piping may be kept at a minimum if the contributing factors are understood and analyzed for the particular service. First among these factors is the selection of proper materials for the service. Pipe is available today in a variety of materials which makes it possible to insure practical permanence of installation to a degree which was unheard of a few years ago—steel, wrought iron, cast iron, copper, brass, aluminum, glass, wood, rubber, lead and many alloys. The engineer in determining the materials which should be used for replacements and additions, should remember that even though the material best suited may be more expensive in first cost it will usually be found to be cheapest in the long run.

Stainless Iron and Steels

An outstanding step in the fight against corrosion in piping has been the introduction of the stainless irons and steels, perhaps more rightly called "corrosion-resisting irons and steels," inasmuch as they are not absolutely stainless under all conditions. These various ferrous alloys are readily obtainable in all standard sizes from several manufacturers. They can be threaded, bent or otherwise fabricated to suit individual requirements. Necessary fittings, such as flanges, couplings, elbows, etc., are also on the market.

To cite a few typical industrial uses for such corrosion-resisting pipe, these alloys are used for acetic acid lines such as are encountered in vinegar manufacture; citric acid from the citrus fruits such as lemons and oranges; aluminum sulphate in water treatment plants; bleaching liquids, such as calcium hypochlorite; nitric acid made from the oxidation of ammonia. In the milk industry it withstands not only the lactic acid in sweet or sour milk but also the abrasive and corrosive action of the cleaners used. Paper mills employing the sulphite process find that it will resist the action of the cooking liquor. Its high strength, coupled with its ductility, makes it suitable for high temperature and high pressure, combined with corrosive conditions.

Copper Pipe for Heating

Copper piping for heating is coming into increasing use. An example of a recent modernization heating job using copper pipe and fittings (Mueller Brass Co., Port Huron, Mich.), is the Philadelphia Stock Exchange building. Though just recently installed, to quote the maker "one result already apparent of the smaller size of piping used is in the volume of heat produced with less fuel."

Sawing Vise for Copper Tubing

A square-end sawing vise for thin-wall copper or brass tubing has been announced by The Borden Co., Warren, Ohio. It is made of aluminum with steel inserts, is self-contained, light and simple to use. Tubing, ⅛-in. to 2-in., is locked into position by means of a reversible vise block. A thumb screw prevents overpressure and crushing. A long "V" trough insures accurate centering and the saw guide prevents the saw blade from "running." This new vise is shown in Fig. 9.

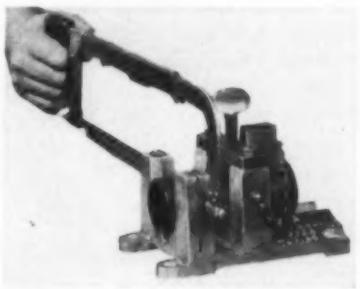


Fig. 9—To make sure the hack saw cuts the tubing with a square end this vise, with a saw guide, has been developed

Pipe of Asbestos and Cement

A pipe composed of asbestos fibre and portland cement, combined under pressure into a dense, homogeneous structure, has recently been introduced in this country (Johns-Manville, New York City). It is produced in several classes, one suitable for flue pipe, one for vent stacks and process liquor lines and four for conveying liquids, vapors and gases under pressures equivalent to heads of 100 to 500 ft of water. It is light in weight, free from electrolysis and tuberculation. Heat resistance is combined with low heat conductivity, and fluids conveyed through the pipe are not contaminated by products of oxidation.

For joining this pipe a coupling with a sleeve of the same material and two rubber rings is available, though several makes of couplings commonly used are applicable. Metallic ells, tees, laterals, crosses, reducers, valves, etc., may be used.

Check Pipe Insulation

THE use of a good heat insulation in sufficient thickness will conserve the largest part of the heat which would otherwise be lost from exposed pipe surfaces and, in addition to conserving the heat, the in-

sulation will also improve working conditions around heated equipment, will produce more uniform products where temperature control and distribution is necessary and will help to protect lines from rapid temperature changes, thus minimizing the damage resulting from internal strains and cracks.

Data have been published which show that the loss in dollars from 100 lineal feet of bare pipe per month will range from $2.24 for ½-in. pipe with steam at 10-lb gage pressure to $36.10 for 18-in. pipe at the same pressure, while at 275 lb and 250-F superheat the corresponding losses would be $16.15 and $297.50.

Such losses from exposed pipe lines are added to by the losses from valves and fittings which are not insulated. Many pipe lines are covered, but valves and fittings are left bare. The tremendous heat loss which results from having only a few fittings uncovered over an extended period of time, especially when the lines are operating at a high temperature, is not always realized. One authority suggests that the total loss from all valves and fittings per unit area be assumed the same as the unit area loss of 18-in. pipe at the corresponding temperature.

The engineer whose piping systems are not insulated at various points or, if insulated, whose insulation is broken or inadequate, can see in these figures what such a condition is costing his plant or building and can put insulation down as one of the important points to check for modernization.

Among recent developments in the insulation field is a pipe covering of the asbestos cellular type which has been placed on the market in a pre-shrunk form.—(Johns-Manville, New York City.) It is designed to eliminate the formation of open spaces between lengths of covering after the job is placed in operation and the material has been dried out. It is available in three finishes, with or without the regular canvas covering—an asbestos paper finish; an aluminum finish which has been designed not to fade; and the regular canvas covering.

A cellular type of pipe insulation for hot water or steam to a temperature of about 300 F has been developed (Norristown Magnesia & Asbestos Co., Norristown, Pa.). It is modern in appearance, having replaced the white muslin usually used on the outside of pipe coverings with an asbesos felt. This makes a 100 per cent asbestos insulation, fire and rodent proof, heavy in construction, with small air spaces. Being hinged at one longitudinal joint it is a quick covering to apply. Its application to pipes is simple and clean and the application labor can be reduced appreciably. A pipe insulation for hot- or cold-water lines has been developed by the same company. The quick application feature is used on this covering as the muslin jacket has been replaced by a surface of aluminum. One type of woolfelt covering can now be used on either hot or cold water work as the inner liner is waterproof and will also withstand temperatures in excess of those reached in hot water work.

A new type of cork covering for cold pipes has been developed (Armstrong Cork & Insulation Company, Lancaster, Pa.). This new cork covering has the features of greatly lowered density, achieved by a new process of manufacture, by which the cork granules are knit more closely together. Conductivity is lowered, and strength of the covering is increased. This covering is uniform, its inside surface is smooth, it fits snugly in place, preventing the possibility of moisture-attracting air spaces between the pipe and the insulation. The same smoothness on the outside surface improves the appearance of the job and increases efficiency.

New Pumping Equipment

THERE have been a number of improvements and developments in pumping equipment which should be looked into by the engineer planning a modernization program. Following are some which have just lately been announced as well as several which have been reviewed in recent issues of HEATING, PIPING AND AIR CONDITIONING:

The new type of rotary displacement pump illustrated in Fig. 10 (manufactured by De Laval Steam Turbine Co., Trenton, N. J.) embodies a number of features, particularly the ability to run at speeds heretofore considered impracticable for displacement pumps.

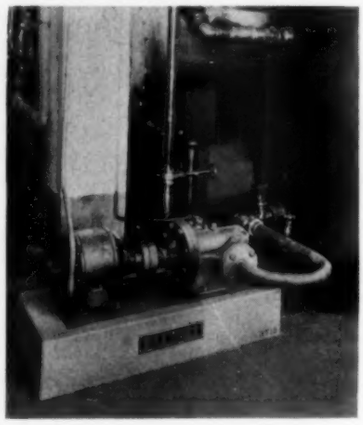
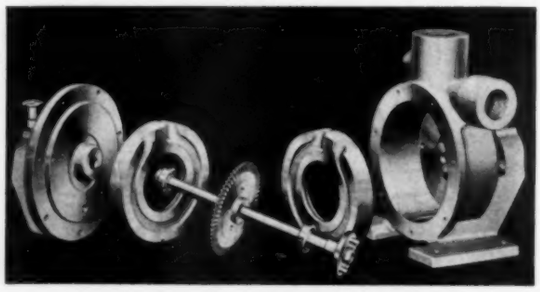


Fig. 10—Installation in lubricating oil system of new type of rotary displacement pump. A feature of this pump is its ability to run at the higher motor speeds and even at turbine speeds

Power is applied to a central or power rotor, which meshes with one or more sealing rotors of such form that they are propelled largely by fluid pressure, with a minimum of mechanical contact. This action results from the shape of the threads, those of the power rotor

Fig. 11—Disassembled view of new self-priming turbine pump showing casings, impeller and removable liners (a patented feature)



being convex, while those of the idler rotor are concave. The velocity of the liquid through the pump is low and there is no trapping or cutting off of liquid in tooth pockets. Because of this, and the fact that there is nothing in the mechanical construction to limit the operating speed, the pump operates successfully and quietly at the higher motor speeds, and even at turbine speeds.

A new line of turbine pumps, recently announced by Westco Pump Corp., Davenport, Ia., provides the self-priming feature of the positive displacement pump together with the constructional features of the centrifugal pump. Removable liners are a patented feature of these self-priming pumps. These liners

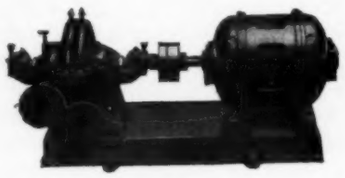


Fig. 12—Two-stage opposed impeller pump. Capacities range up to 350 gpm

are designed so that they form the liquid channels or races, which together with the impeller, accomplish the pumping. Each pump housing or casing is built to accommodate a number of different sized liner-impeller combinations. In this way, a wide range of capacities or pressures can be produced in one pump without disturbing intake or discharge connections. These liners can be furnished in special non-corrosive or wear-resisting metals. A disassembled view of this pump is shown in Fig. 11.

In Fig. 12 is shown a two-stage opposed impeller pump (Economy Pumping Machinery Co., Chicago, Ill.), suitable for all clear water purposes where pressures up to 150 pounds are required. Capacities range up to 350 gpm. This size of pump fulfills a variety of needs, particularly such services as water supply for high buildings, industrial plant process work, etc. Ball bearing construction is used. The opposed impeller design, impellers mounted "back to back," gives hydraulic balance without the use of auxiliary devices. This design enables the use of a short stubby shaft which is extremely rigid, resulting in increased life of packing rings together with the advantage of small floor space.

Improved horizontal duplex steam pumps, especially designed and fitted for handling either water or chemical solutions, have been announced by the Worthington Pump and Machinery Corporation, Harrison, N. J. Built in three different types—valve plate, turret and pot valve—these units incorporate several features, among them being the use of stainless-steel drop-forged valves.

Ingersoll-Rand, New York City, has recently announced a motor-pump unit.

A motor-pump unit for air washers, filters, brine circulation, transferring oils or chemical solutions, hot or cold water circulation and general industrial applications has been announced by the American Steam Pump Company, Battle Creek, Mich. Capacities range from 5 to 90 gpm for heads up to 120 ft and up to 450 gpm for a head of 60 ft.

The pumping unit is of a single-stage, single suction centrifugal type; the motors range from 1/6 to 10 hp and operate at speeds of 1,750 to 3,500 rpm.

The centrifugal pump unit of Lawrence Pump & Engine Co., Lawrence, Mass., will pump against heads of 150 ft or 65 lb pressure in the single-stage types and twice that when furnished with two-stage unit in series. Capacities range from 5 to 200 gpm.

Another manufacturer who has recently announced a motor pump unit is Pennsylvania Pump & Compressor Co., Easton, Pa.

Many Developments in Air Conditioning

NO better summary of the possibilities in air conditioning for modernizing industrial processes or for contributing to human comfort could be presented than the paper by Willis H. Carrier which appeared in the December issue of this journal and which was presented at a meeting of the *A. I. E. E.* in New York City.

In general, industrial applications of air conditioning are warranted whenever the tangible or direct savings will pay for the cost of the installation within three years. The economic requirement is that the cost of owning and operating, which includes interest, liberal depreciation and maintenance, shall be considerably less than the economies effected by the installation. Frequently economies effected by air-conditioning installations are almost startling. One ceramic manufacturer found it was possible to double his production without increasing his factory floor space as he had intended. The cost of a relatively small air-conditioning system was only one-fifth of the cost of the proposed increase in building. In addition, the quality of his product was improved and the reduction in losses in production more than paid for the equipment every year. To give another instance, a large tobacco manufacturer saved in one department by the reduction of the amount of scrap tobacco enough to pay for the initial cost of the equipment six-fold in one year.

As for the comfort aspect of air conditioning, any device which will increase man's comfort and his satisfaction with his surroundings tends to increase his efficiency. Further, if such a product actually improves the conditions affecting his health, and decreases the fatigue from his day's labor, then its economic advantage is unquestionable providing it can be produced at a cost commensurate with the returns. In other words, it must pay its way either through increased productivity or through increased comfort and health. What are the returns? Here's one example: The first installation of air conditioning in a theater in New York City in 1924 paid for the entire installation the first summer that it was operated. It increases the summer attendance fully 50 per cent and the average yearly attendance from 12 per cent to 15 per cent while the cost of air conditioning varies from 5 per cent to 10 per cent.

Equipment Development

To make possible the advantages and benefits described manufacturers have developed the most complete equipment, outlined in brief in the following:

Steam Ejector Cooling

Typical of these developments is the steam ejector or steam jet cooling system.

There was recently tested a piece of refrigerating equipment (Westinghouse Electric & Manufacturing Company) of large capacity using steam ejectors to produce the cooling effect. In this test a tank of several hundred gallons of water at room temperature was frozen to a slush ice in a few minutes, indicating the effectiveness of this type. Except for some small

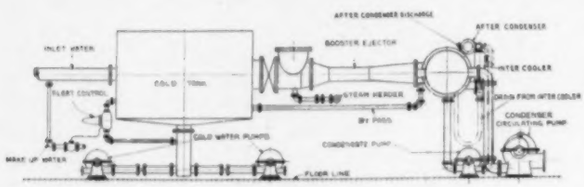


Fig. 1—Diagram of a steam-jet refrigeration machine

pumps, there was no rotating apparatus in this equipment, and the complete unit was simple and relatively small in size. The ejector itself was developed from those used in connection with condensers for large steam turbines.

Steam jet refrigeration produces cooling effect by evaporation. Steam jet compressors or booster ejectors maintain the vacuum required. The water to be cooled is put into the cold water tank through a series of spray nozzles. (See Fig. 1.) This promotes rapid vaporization of a portion of the water which in turn carries heat away from the remainder of the water, reducing its temperature to the equivalent temperature of the vacuum maintained. The cold water falls to the bottom of the tank from which it is removed by a condensate-type pump and returned to the cooling load. Additional water to take the place of the portion evaporated or otherwise lost in the cycle is introduced by a float valve.

In Fig. 2 is illustrated the steam ejector cooling equipment designed by Carrier Engineering Corp., Newark, N. J. It consists of (A) evaporator tank upon which the vacuum is drawn, causing water to boil at low temperature; (B) chamber containing steam ejector nozzle, the effect of which is to draw a vacuum on tank "A"; (C) condenser tube; (D) condenser tank where water vapor from tank "A" exhausted from tube "C" is condensed again to water; (E) motor operating pump "F," which circulates cold water through tank "A" to cooling coils in air conditioning unit; (F) cold water pump; (G) discharge outlet for condenser water used in tank "D"; (H) and (I) outlets for condenser water.

A 75-ton vacuum refrigeration installation (Foster-Wheeler Corp., New York, N. Y.) for an industrial plant serves as a heat pump. Heat removed in the refrigerating process is reclaimed in the heat exchanger. The system is located out of doors.

In the steam ejector refrigerating unit of the Ross Heater and Mfg. Co., Inc., Buffalo, N. Y., water is cooled through a range of temperature between 35 and 70 F. Vacuum is maintained in the evaporator by a series of air ejectors and condensers. The primary ejector compresses the steam which has been flashed, plus the air which has entered the system with the water, from 29.75 in. to 28 in. Hg. Either high pressure or low pressure steam may be used as the compressing medium. In the primary condenser, the steam from the evaporator and the propelling steam from the primary ejector are condensed, while the air is further compressed from 28 in. to 22 in. Hg. and then to atmospheric pressure by the secondary ejectors. The inter-and-after condenser condenses the propelling steam of the secondary ejectors.

These units may be operated with steam at any available pressure. While the steam consumption decreases as the steam pressure is increased, it is often more eco-

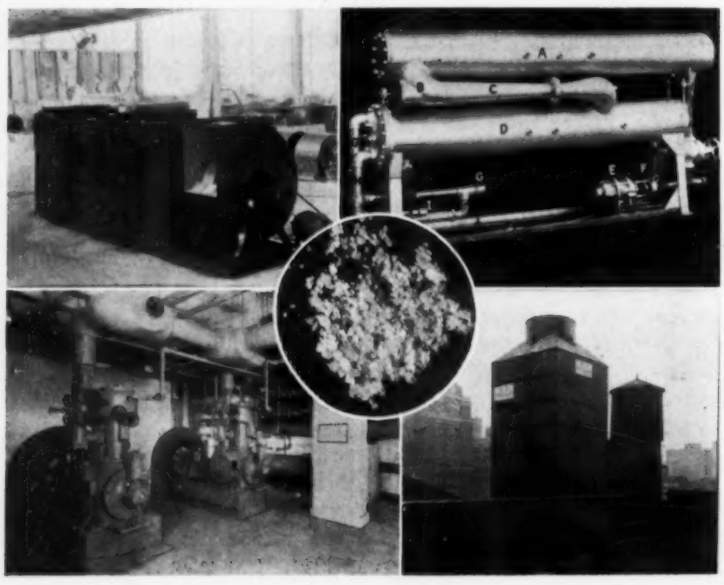


Fig. 2

Upper right—Steam ejector cooler. See text for explanation of operation

Lower left—Compressors in the machinery room of a public building

Upper left—Air-conditioning unit designed for ease and convenience in shipping, handling, locating, and installing

Lower right—Cooling tower installed in connection with the air-conditioning system in a movie theater

In circle—Lamisilite, used for dehumidifying air

nomical to operate them at low pressure in installations where a supply of exhaust steam or low pressure heating steam is available.

For Any Air Conditioning Problem

An increasing number of makers of air conditioning equipment are manufacturing or preparing to manufacture equipment designed not merely to meet certain catalog specifications but also to render demonstrable benefits in lessening costs in providing suitable atmospheric conditions for human comfort and for the fabrication of manufactured goods, also in enabling manufacturers to turn out a better product. Typical are the washers and dehumidifiers manufactured by York Ice Machinery Corporation, York, Pa., that are adaptable to air conditioning problems where accurate and close range of humidity is required and which are built in a wide range of sizes and capacities. These range from one-half to twenty tons capacity and are adaptable for multiple installations and for use with ammonia, freon, brine or water as refrigerants.

Fig. 2 shows the York compressors and associated equipment in the machinery room of a large commercial public building in Kansas City.

A brine spray cooler made by Niagara Blower Co., Buffalo, N. Y., is a unit for low-temperature air-conditioning work which is becoming of increasing importance in the food industries. The unit supplies cooled and humidified air; in meat-packing plants, for instance, this retards drying out of the product and effects a saving.

Vilter Mfg. Co., Milwaukee, Wis., has announced a rotary compressor. While these compressors were designed for ammonia booster service they can be used with the new refrigerant "freon" for air conditioning work. These compressors operate through a range of from 14-in. vacuum on the suction side to 40-lb pressure on the discharge side.

It has been interesting to watch the development of various types of fin radiation from the assembly of cartridge tubes in a cartridge factory in Boston, some years ago, to the modern types the designs of which are based on much metallurgical and heat transfer research. Among these is the product of the Aluminol Products Corporation of Cleveland, Ohio, illustrated here. (See Fig. 3. It is cast in light weight corrosion-resisting alloy and is recommended by the maker for its high heat transfer and defrosting rate in direct expansion or brine circulation in all industrial processes.

Unit Air Conditioner

As the air conditioning industry develops, new equipment is designed or old equipment is improved to meet a great variety of conditions. There are portability, ease of handling and shipping and installing to be considered. Sometimes doors are so narrow as to bar the entrance of completely assembled air conditioning equipment. Sometimes the space on the floor is so small as to cause inconvenience in its erection. Sometimes there is no floor space available at all and the device must be hung from the ceiling.

These and other factors have been taken into consideration in the design of the new type of unit air conditioner (Fig. 2) for human comfort and for industrial processes manufactured by Carrier Engineering Corporation, Newark, N. J.

This equipment consists of four sections that may be assembled by bolting together. These contain return and by-pass air connections and dampers, preheater, sprays, baffle eliminators, reheater, and standard assembly fans and motor. In the preheater Aerofin flexitube is used.

In Fig. 2 is also illustrated a cooling tower (Foster-Wheeler Corp., New York) in connection with air conditioning of a motion picture theatre in Philadelphia. The specifications called for a fireproof construction, a compact unit which may be mounted on a roof but which would take up such a small space as not to be objectionable and which would be silent in operation and positive, not dependent upon natural draft. This is a metal-cased cooling tower which is fitted at one corner of the theatre building roof in a way that does not interfere with the skylight or ventilators already installed. The tower has a positive flow of air but instead of using forced draft fans, an induced draft fan is placed in the discharge opening at the top of the tower. The fan is of the areoplane propeller type and is provided with four blades in order to insure noiseless operation. It is designed to cool 1,000 gallons of water per minute close to the wet bulb temperature. The tower is installed close to one of the main thoroughfares in Philadelphia and adjacent to many buildings so that any spray or noise would be objectionable and an immediate source of complaint.

Dehumidifying With Chemicals

Much research has been applied to the use of products that have an unusual ability to take up moisture from the air. Among these are silica gel, alumina and calcium chloride. The illustration in Fig. 2 shows another product of this character called lamisilite, which is proposed for small types of air conditioning equipment. It is stated that its value lies in its low cost and the low temperature at which it may be regenerated. This product may be procured through Robert G. Guthrie, chief metallurgist, Peoples Gas Light and Coke Co., Chicago, Ill.

Filtering and Dust Collecting

In the following descriptions of air cleaning equipment there are several types of equipment for filtering air. This equipment covers a wide range of applications from small buildings to large and for many industrial applications, including the removal of dust from air for air compressors, diesel engines, and similar equipment.

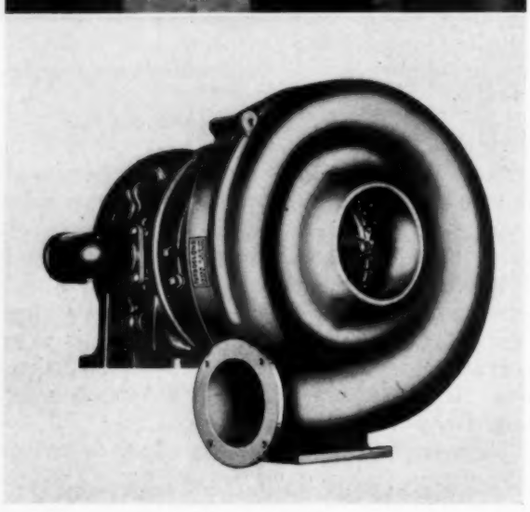
The Owens-Illinois Glass Co., Toledo, Ohio, has produced a filter with a filter medium of glass wool, which is covered with viscous material, said to be unaffected by temperatures above 220 F. The glass wool is packed in cardboard frames which are thrown away when dirty. The fillers weigh 2 lb, are 20x20x2 in. in size, and fit into steel frames. They have a capacity of 800 to 1,300 cfm. In Fig. 4 (center) is shown an installation of these filters in the Ohio Bell Telephone Bldg., Toledo, Ohio.

Fig. 4—

Top—Filter for collection of large quantities of dust from industrial processes

Center—Glass-wool air filters in the Ohio Bell Telephone Building

Bottom—Dynamic precipitator for removing valuable or objectionable industrial dust, recently announced



The new filter of the Davies Air Filter Co., New York City, uses a filter medium which is set in steel frames and thrown away when dirty. This equipment is recommended by the makers for all air filtering purposes, including filtering of air for air compressors and diesel engines. The size of the units is 24x13½x1 in.; they have a capacity of 200 to 400 cfm at 25 to 50 fpm.

The American Air Filter Co., Inc., Louisville, Ky., recently announced two new filters, one using as the filter medium fabricated split wire woven into pads and contained in cardboard casing to be thrown away when dirty and another type described as having a removable filter pad semi-permanent in character. Both are available in sizes 20x20 and 16x25 in.

Coppus Engineering Corp., Worcester, Mass., announces an all-wool felt filter which is not affected by dampness or oil in the air. The medium is an all-wool felt glove, spread over a frame. When dirty it is cleaned by a vacuum cleaner.

The W. W. Sly Mfg. Co., Cleveland, Ohio, makers of dust arresting apparatus, recently presented to the industrial world a dust filter, Fig. 4 (top) which is used for the collection of comparatively large quantities of dust from industrial processes. Sometimes valuable products are saved in this way, which more than pay for the cost of the installation.

In installing the filter the sources of the dust are connected to the filter and to an exhaust fan by a suitable piping system. The fan, located behind the filter, draws the dust laden air into it. Under certain conditions the fan may be placed between dust sources and filter, blowing the dust into it. The dust laden air enters the dust chamber of the filter. Because of the large size of this chamber the velocity of the air is reduced to such an extent that a large volume of dust settles in the hoppers. The remaining float dust is filtered out of the air by the cloth envelopes. This dust adheres to the cloth lightly and is easily removed by the mechanical cleaning device and falls into the hoppers. The dust may be accumulated in the hoppers and drawn off at intervals by hand operated valves, or it may be taken away continuously by automatic continuous dust valves to be

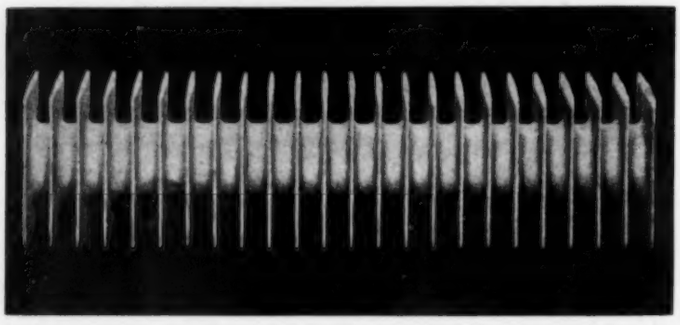


Fig. 3—Heat transfer surface of light-weight, corrosion-resistant metal

spouted into a bin or receptacle, or to be further handled by a screw conveyor or other means of conveying.

The dust collector just announced by American Air Filter Co., Inc., Louisville, Ky., Fig. 4 (bottom), is equipped with an impeller which performs the dual function of moving the air and precipitating the dust as a continuous operation. It is a self-contained unit either belt-driven or direct connected and may be mounted directly above a suitable hopper for collecting the dust in industrial operations. It is designed for use near the source of dust in order to eliminate piping and duct work and is adjustable to various discharge positions.

Sheet Metals

Heating, piping and air conditioning equipment is bought these days not only for the results that may be obtained through its use but also because of the lasting qualities of the equipment, its resistance to rust and deterioration. This is evidenced in developments of sheet metals for duct work.

Many kinds of sheet metal are now available to meet corrosive conditions. Sometimes sheets of alloy metal or sheets surfaced thinly with a corrosive resisting metal are used. The Republic Steel Corp., Massilon, Ohio, makes its stainless steel for meeting the corrosive action of acids, alkalis, corrosive salts and gases. In Fig. 5 is an installation of this company's corrosion-resisting sheets in a laboratory ventilating system.

The American Rolling Mill Co., Middletown, O., recommends its ingot-iron sheets for resisting rust and meeting corrosive conditions and its steel sheets for ducts where conditions are less severe. Wrought-iron sheets are available from A. M. Byers Company, Pittsburgh, Pa.

Sound Isolation

Heating and air conditioning engineers have been giving an increasing amount of attention to transmission of noises from fans, pumps, compressors, etc. Much ingenuity has been manifested in recent years in devising methods for sound isolation.

A device for this purpose has been developed by Korfund Co., Long Island City, N. Y. It is a sound damper, designed for use with small refrigerating machines, air conditioning units, fans, blowers, motors, etc. These dampers are drilled and tapped to permit bolting to the machine base or leg and the lower housing is drilled for two ⅜ in. bolts for anchoring to the floor. The maximum load for each damper is 400 lb. Each unit is loaded at the factory with cork or other resilient sound absorbing material.

Fig. 6 shows a new floating base for fan and motor. There is no metal contact between bolts holding down base and fan. Live rubber used not "in compression" but "in shear" prevents the transmission of vibration or sound from the fan or motor through the base. This is made by Buffalo Forge Co., Buffalo, N. Y.

General Electric Co., Schenectady, N. Y., has designed a self-contained steel base which can be shipped with the motor, and which provides insulation against vibration and may include a sliding feature for belt-tightening.

Window Units

Research in air conditioning and noise prevention has produced window unit equipment that is used not only for eliminating noise and dirt but also for ventilating, dehumidifying and heating the air in winter or cooling it in summer.

A device of this kind attached to the window in a hotel room is shown in Fig. 7. In this cabinet all the elements of complete air conditioning are combined in one unit. These units can be built into new construction with minor additional piping, wiring or equipment or they may be applied to existing buildings. They are made by Campbell Metal Window Corp., New York. N. Y.

It is surprising to many that street noises as well as dust and dirt from street traffic are quite noticeable not only on the lower floors of metropolitan office buildings and other larger structures but in the higher stories as well.

A combination noise eliminator, ventilator and air filter which looks somewhat like a radio cabinet and is made by Burgess Battery Co., New York, N. Y., is shown as applied to the windows of an office on the eighteenth floor of an office building in Fig. 7. These units are, of course, adaptable to windows wherever clean air, air distribution and quietness are desirable.

Fans for 40 Below Zero

The fans and motors shown in Fig. 8 are installed in a modernization project in New York City, in tun-

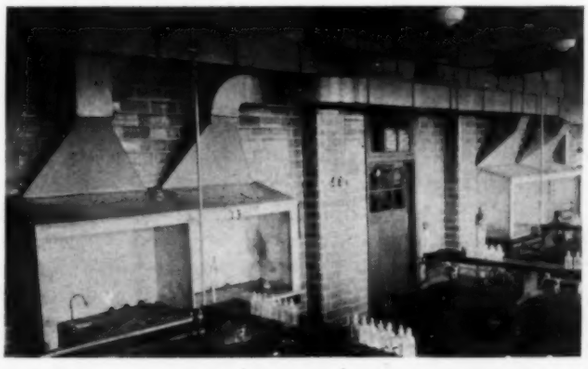


Fig. 5—Corrosion-resistant sheets used in the construction of ducts for a laboratory exhaust system

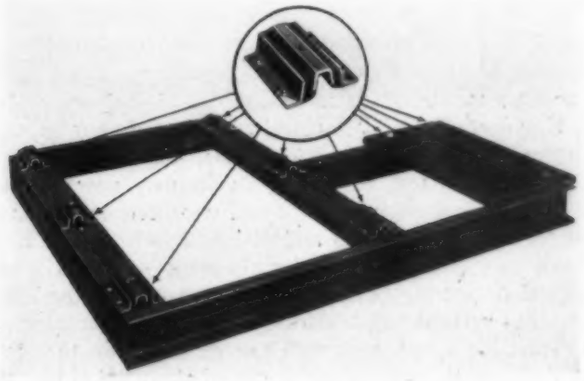


Fig. 6—New floating base for fans and motors

nels for the quick freezing of foods. These twenty-eight 30-in. fans, made by De Bothezat Impeller Co., New York, N. Y., are driven in the tunnel by motors designed to operate at 40 degrees below zero F. They operate in two groups of fourteen each in parallel. Each group handles 100,000 cfm at 1-in. pressure.

Fans made by the Duriron Co., Inc., Dayton, Ohio, feature resistance to corrosion. They consist of a new line of exhaust fans for handling corrosive fumes in which the housing is in one piece and the impeller, which is hung directly on the motor shaft, and all other moving parts are cushioned on rubber. In fan sizes 8-in. and up, ball-bearing motors are used; smaller sizes are equipped with sleeve bearings. All parts which touch fumes are made of a special alloy which does not require coating or painting. The design is such that all moving parts may be withdrawn from the fan without disturbing the duct connections.

Another corrosion resisting fan and exhauster (United States Stoneware Co. New York, N. Y.) is made of chemical stoneware and is designed for use where corrosive gases are encountered. In addition to the protection from corrosion due to its stoneware construction it is also protected by an outer armor of cast iron. This exhauster is equipped with impellers of the non-clogging type which are fastened to the motor shafts by a four-jaw clamp, insuring proper alignment and rigidity but enabling removal. The discharge may be swung through 360 degrees.

Among the newly developed fans that claim the attention of engineers is the Aerocool, an airplane propeller type fan designed for quietness and maximum air delivery. This fan is light weight, all steel welded construction, is designed to give long life and to avoid breakages. The standard make motors that drive these fans were selected because of the self-cooled feature and because they are designed for infrequent lubrication. They are available in all standard voltages and frequencies and in sizes 12 in. to 48 in. They are made by Myers Electric Co., Pittsburgh, Pa.

Engineers who heretofore have adapted fans to caps or pents, for toilet exhaust stacks, central vent ducts and other vertical ventilating shafts may now procure a complete assembly of pent and weatherproof fan and motor made by Bishop and Babcock Sales Co., Cleveland, O. The fan is of a multi-blade type and is designed to operate quietly, has no contact with the housing, has vertical ball-bearing type motor, either constant or variable speed, and with fan contained in the same housing so that the motor is out of the path of the air. The housing is of heavy sheet copper with sides extending 3 in. below the coping to prevent water seepage. Motors range from ½ to 5 hp, and free air deliveries from 3,000 to 6,330 fpm.

Fig. 7 (right)—Sound eliminating and window air-conditioning unit in a hotel room. Left—Combination noise and dust eliminator and ventilator in an office

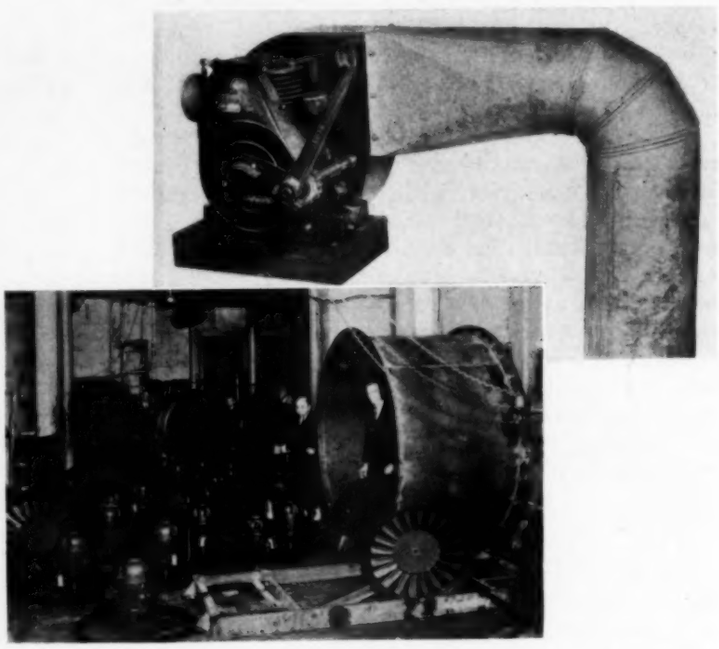


Fig. 8 (below)—A group of 28 fans, 30 in. in diameter, equipped with special motors to operate at minus 40 F. Above—A manhole ventilator

In modernizing pipe lines in tunnels, manholes, etc., the air of which may be foul with gas, chances cannot be taken with the lives of workmen. A device for blowing foul air out of manholes and tunnels is illustrated in Fig. 8. It consists of a small four-cycle gasoline engine directly connected to a fan which delivers air through the attached duct up to 1,000 cfm. It weighs 80 lb and is available mounted on a flat base or light truck. This manhole blower is introduced by American District Steam Co., North Tonawanda, N. Y.

Safety is the feature of the welded steel safety guards for ventilating fans made by L. J. Wing Co., New York, N. Y. Models are available for single, two and three phase alternating current, direct current, pulley drive. High speed types for industrial use also are available. The fan wheel is of a screw-propeller type designed to give a uniform velocity across the air stream

rather than a high velocity at the circumference and a low velocity in the center.

Humidifiers

In mills where it is necessary to maintain certain relative humidities and where it is desirable to cool the air for the comfort and efficiency of the employes, these conditions can be obtained by balancing air change with evaporation. A system for doing this is the product of Parks-Cramer Co., Fitchburg, Mass., which comprises humidity regulators, temperature controls, limiting thermostats, starting switches and relays, ventilating fans, and other equipment. When the humidifiers are put into operation it is observed that the evaporating and cooling effect is in proportion to the ability of the air to absorb moisture and to the amount of air change. The amount of air change is then used as a regulator to control evaporation. Increased ventilation reduces the relative humidity and reduced ventilation increases it. As more ventilation is provided the humidifiers operate a greater length of time until a point is reached at which the humidifiers operate continuously. In Fig. 9 is a cross-section view of this system.

This same concern also makes a spray type humidifier which may be applied in offices, showrooms, laboratories and similar enclosures. It has a 21¼ by 10¼-in. base and is 12-in. high, contains a water tank, float valve, safety overflow, high speed centrifugal humidifier and fan, is connected to water supply and drained by small copper tubing and to electric power by means of plug in any light socket. It runs on 110 volt, 60 cycle electric current, consumes 60 watts of electric power, and is designed to maintain 40 to 65 percent relative humidity in spaces up to 8,000 cu ft.

In specifying the required number of humidifiers for a textile mill or any other industrial process, it is necessary to consider the kind of walls and roof, the number and kind of openings, the equipment layout and the relative humidity required. Rooms enclosed mostly by glass require a somewhat greater output of vapor than others. Also, a factor of safety must be allowed for the days of high winds for on such days the number of air changes per hour is greater than on quiet days. For instance, a tentative estimate for the humidifier made by Southworth Machine Company, Portland, Me., is one humidifier for each 12,000 cu ft of space depending upon the factors enumerated above and upon the character of the room and its contents.

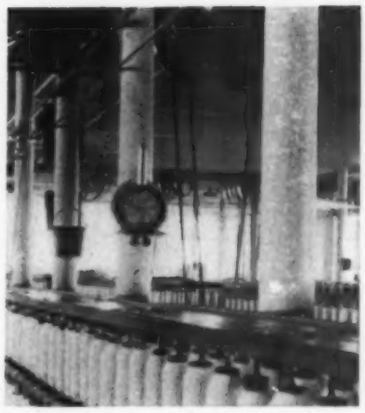


Fig. 10—Combined relative-humidity controller and recorder in a textile mill

In the textile mill illustration in Fig. 10 is a combined humidity controller and recorder, which recently was installed. At the time of the installation the relative humidity of the air near the instrument was determined by means of a sling psychrometer. Then the instrument was adjusted and the pen set to correspond with that humidity. Then the control pointer was set at the humidity desired. As the relative humidity falls below or goes above this point an air operated diaphragm valve

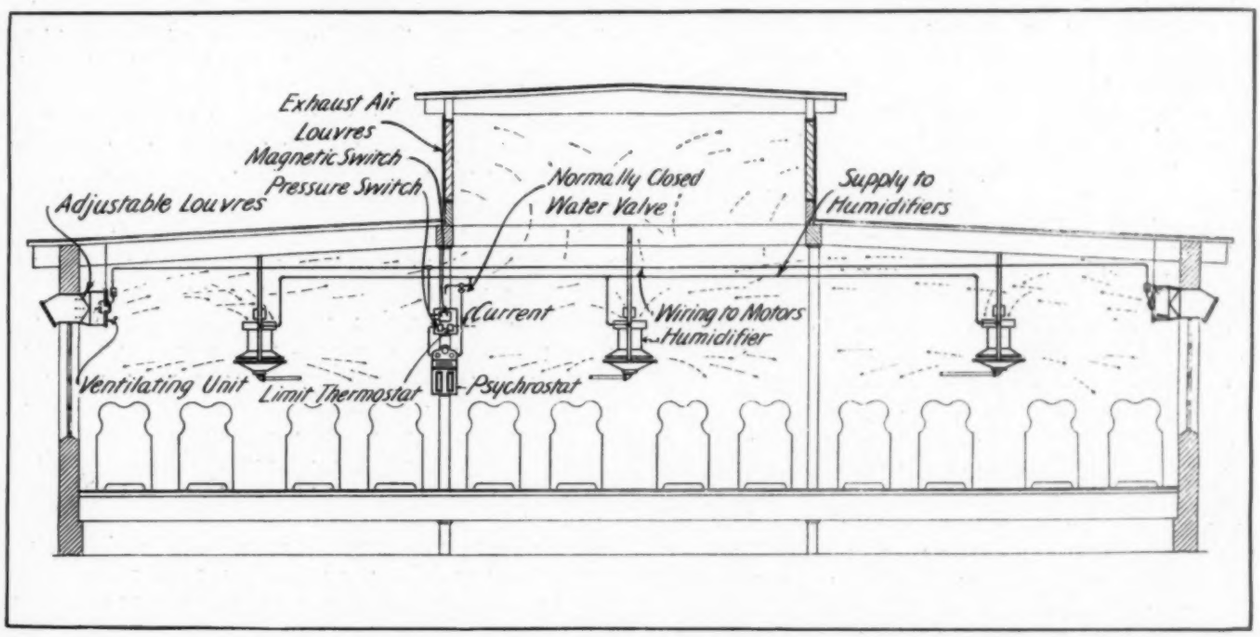


Fig. 9—Cross-section of a system for controlling air circulation and humidity in plants

on the supply line to the humidifiers is opened by a small air relay at the bottom of the instrument beneath the clock. In this way the air may be maintained at 75 per cent relative humidity one day and 65 per cent relative humidity the following day. This instrument is designed to control a space 100 x 100 ft in the ordinary textile mill. It is made by International Moistening Company, Providence, R. I.

Developments in Drive Equipment

In an article in the October issue, the maintenance of motors as a means of saving money was stressed; selection of the right type and size is of utmost importance in keeping power cost down. One concern makes it a practice of requiring reports from its maintenance men on motors which are cool to the touch; such motors are underloaded and it pays to swap them around until each is fairly loaded.

Fundamental to any consideration of motors is consideration of switches and controls, and developments in this phase of heating and air conditioning have been numerous. An example is cited by Cutler-Hammer, Milwaukee, Wis., in describing the control for a motor driving a fan in a bank building, installed ten years ago, and a similar installation in a large office building installed in 1932. In the first instance an open circuit breaker is used; in the second, totally-enclosed circuit breakers. In the first case, there is an open controller; in the second a totally-enclosed starter arranged for outside operation. In the first case there is open wiring between the conduit and the controller; in the second, no exposed wiring; conduit runs directly into the starter enclosure. In the first case the equipment is wall mounted; in the second there is a self-supporting floor type frame. The old job has an open motor; the new, a semi-enclosed motor with protecting cover over commutator and brushes. In the first case sleeve bearings are used (with an improvised drip pan to catch oil), and in the second ball bearings.

A new line of explosion-resisting line starters and a new breaker for circuit protection are among the recent developments of Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Trumbull Electric Manufacturing Co., Plainsville, Conn., recently made an addition to its line of indus trial switches. These instruments are featured by a vise-type vacuum clamp which reduces heating at the fuse terminals and a type of roll contact designed to maintain perfect line contact under pressure. The roll changes in position with each operation, making it self-wiping.

A new line of manually- and electrically-operated, trip-free, multi-pole air circuit breakers for the control and protection of circuits in all fields has been announced by the General Electric Company, Schenectady, N. Y. These breakers are obtainable in metal-enclosed construction, with or without pull box, metal-enclosed with pull box and disconnecting devices to permit inspection of the breaker while it is disconnected from the source, or mounted in dead-front and metal-enclosed switchboards which are shipped assembled from the factory.

Allen-Bradley Co., Milwaukee, Wis., has developed a number of controls. One of its starters, typical of a large group of across-the-line switches used with almost any type of squirrel-cage motor, has a splash-proof type of cabinet which may be considered in connection with equipment used near water sprays or humidifying equipment. The Square D Company, Milwaukee, Wis., manufactures a number of controls applicable to the modernization of heating and air conditioning equipment.

Steam engines or turbines may frequently be used for driving ventilating fans or other equipment to reduce power costs. An engine (Troy Engine & Machine Company, Troy, Pa.) driving a ventilating fan in the Gundlach school, St. Louis, Mo., operates 8 hours daily, 20 days per month and 10 months per year. The fan delivers 69,300 cfm of air against a static pressure of 1½ in. Engine costs are: Annual fixed charges, $223.30; annual operating cost, $159.96; total annual cost, $383.26. It is estimated that the annual return on the investment is 32.7 per cent.

General Electric Company has recently announced a new mechanical-drive, non-condensing turbine for driving fans, pumps, etc.

In many plants and buildings, opportunities will be found to modernize drives to advantage; manufacturers have made several announcements of improvements in recent months.

Dayton Rubber Mfg. Co., Dayton, Ohio, makes drives in ratings from fractional to 1000 hp and over. Belts are of a cogbelt construction. This concern has developed a new line of light-weight V-pulleys made of pressed steel welded at the rim and hub, used with drives up to 7½ hp.

Allis-Chalmers Manufacturing Co., Milwaukee, Wis., now offers a steel V-pulley; this concern makes a complete line of texrope V-belt drives. A new motor-reduction unit for use where low-speed drives are required has also been announced by this concern.

A small speed reduction unit with an enclosed motor drive has been placed on the market by Merkle-Korff Gear Company, Chicago.

The Manhattan Rubber Mfg. Division of Raybestos-Manhattan, Inc., has developed a V-belt for use with air conditioning equipment, one type for light-duty, high-speed service and another for heavy duty. No "inelastic stretch" is featured.

The motor base made by Rockwood Mfg. Co., Indianapolis, Ind., was recently used in the modernization of a flat belt drive for a compressor in a large plant; motor and compressor were formerly located 30 ft apart. This base enables the weight of the motor to be cradled in the belt, providing automatic control of belt tension and permitting a short-center drive with a flat belt.

A new leather belt designed to prevent slippage has been developed by E. F. Houghton & Co., Philadelphia, Pa. The belt is treaded, the treads being indented on the surface under pressure. This concentrates the pressure between the belt and the pulley.

Noiseless operation and durability are among the features of the chain belt drives made by the Link-Belt Co., Chicago.

N. J. Oak, Lynn, Mass., is the manufacturer of a V-belt variable speed drive, consisting of two cone-faced intermeshing flanged discs, between which a standard V-belt runs; speed is changed by setting the discs closer together or farther apart as may be required.

Heating · Piping
and Air Conditioning

American Society of Heating and Ventilating Engineers JOURNAL SECTION

JANUARY 1933

Material in this Section prepared by Publication Committee: F. D. Mensing, *Chairman;* E. O. Eastwood and F. E. Giesecke
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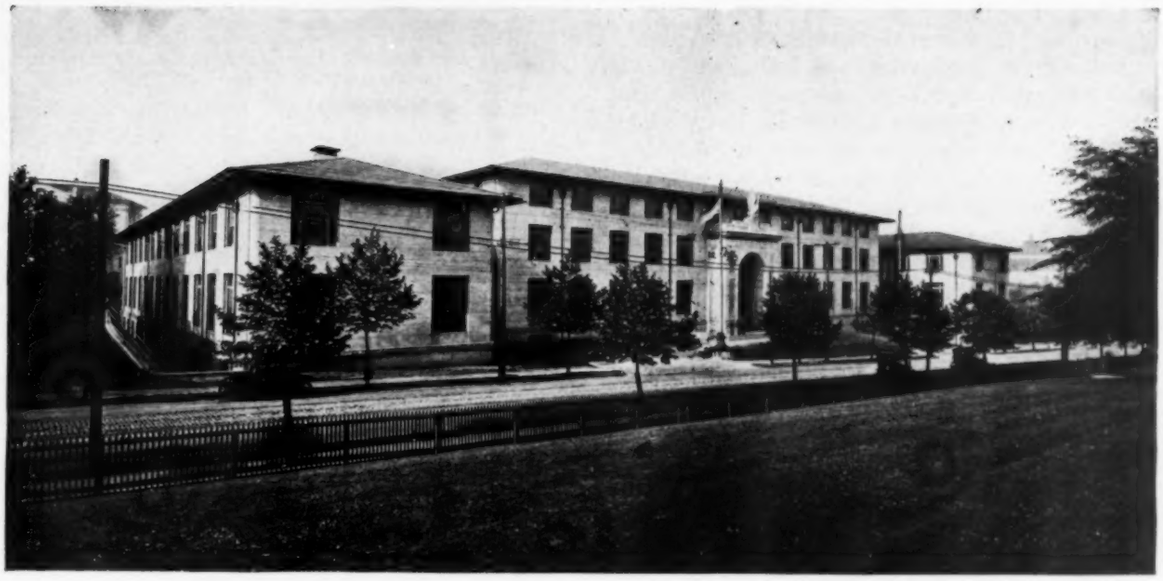

Pittsburgh Experiment Station of the U. S. Bureau of Mines where the Research Laboratory of the American Society of Heating and Ventilating Engineers is located

Cold Walls and Their Relation to the Feeling of Warmth

By F. C. Houghten[a] *(MEMBER)* and Paul McDermott[b] *(NON-MEMBER)*
Pittsburgh, Pa.

THE effects which the thermal properties of man's atmospheric environment have on his feeling of warmth and his body reactions have been the subject of extensive research carried on in recent years by the physiologist and the air-conditioning engineer. Since 1920 a series of investigations of this subject have been carried on by the A. S. H. V. E. Research Laboratory in cooperation with the United States Bureau of Mines and the United States Public Health Service. Results of the investigations have been published in the TRANSACTIONS of the Society. Similar studies have been made by Harvard University.

Thermal equilibrium in the human organism is maintained largely through dissipation of heat to the surrounding atmosphere through evaporation of perspirtion and through convection, and by radiation to surrounding surfaces. Evaporation of perspiration, either sensible or insensible, depends upon the temperature and vapor pressure of the atmosphere and the availability of moisture on the body. Air motion is necessarily an important factor in heat loss by evaporation, since it removes the moisture-laden air near the body and replaces it with air having greater capacity for removing moisture. As demonstrated by an earlier Laboratory study[1, 2], the control of the amount of perspiration available for evaporation is the body's most responsive method of regulating heat dissipation; through its reflex control of perspiration, the body maintains temperature equilibrium over a wide range of atmospheric conditions and for varying rates of heat production resulting from increased activity.

Heat dissipation from the body to the surrounding air through contact and by convection currents is generally referred to as convection loss, and depends upon the temperature difference between the body surface and the dry-bulb temperature of the air. Air movement over the surface or through the clothing removes the warm air next to the body surface and replaces it with cooler air, thus also having an important effect upon the heat loss by convection.

Heat loss by radiation takes place directly from the outside visible surface of the clothed body to the visible surfaces of all surrounding walls and objects in view of it. Although the heat lost by radiation passes through the intervening air, it is for all practical purposes independent of the physical properties of the atmosphere. Such heat loss is in accordance with the Stefan-Boltzmann radiation law and depends upon the surface temperature and emissivity of the visible areas of the clothed body, the solid angle subtended at a particular point on

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For presentation at the 39th Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Cincinnati, Ohio, January, 1933.

[1, 2] Numeric references refer to Bibliography.

the body surface by the surfaces of the walls and other objects, and on the temperature and emissivity of the surface of the walls and other objects in view. Because air circulates through and under the clothing which normally covers a large part of the body, the temperature of the visible surface of the clothed body is more nearly that of the air than that of the body surface or 99 F. Hence, the clothed part of the body is much less subject to variation in heat loss by radiation than is the smaller area of the uncovered portion of the body surface. Within the limits met in practice, the varying surface characteristics of clothing, walls, etc., have little effect on heat dissipation by radiation because, at temperatures commonly found, the emissivity constant for such surfaces is assumed to have the maximum value or unity.

Most of the early studies by the Laboratory and cooperating organizations covering the effect of atmospheric environment on man's feeling of warmth were made in rooms surrounded by well insulated interior walls. There were two objects in doing this: first, to simulate conditions in buildings to which air conditioning based upon the findings was most likely to be applied; and second, to simplify an already complicated problem by the elimination of the variable radiation factor. Although there was no misunderstanding of the importance which it plays in the dissipation of body heat, there may have been some under-estimation of the degree to which heat loss by radiation may vary under different types of building construction and occupancy. The two factors which minimize the variable effect which radiation plays in heat loss from the body are the effect of clothing and the comparatively small differences in the respective inside surface temperatures had by walls of common types of construction when exposed to the same outside and inside air temperatures. The temperatures of inside surfaces of exterior walls of air conditioned space follow more closely the inside air temperature than they do the outside temperature. Three walls built-up as follows will give about as wide a variation in thermal transmission as is met with in building practice: first, a very cheap and poorly insulated construction, made of inside plaster on lath, studding, and outside siding; second, an 8-in. brick wall with 1⅝-in. furred space, lath and plaster; and third, a 16-in. brick wall with 2-in. cork insulation and plaster. These three walls have air to air transmission coefficients of 0.395, 0.250, and 0.094, respectively. If an inside film conductance of 1.6 is assumed, under an outside temperature of zero and an inside temperature of 70 F, the resulting inside wall surface temperatures will be 52.7 F, 59.1 F, and 65.9 F, respectively.

The importance which variation in radiation may play in maintaining thermal equilibrium of the body may be calculated if the magnitude of the factors involved are known. According to Stefan-Boltzmann's law, heat dissipation by radiation is given by the equation:

$$R = 0.172 \times 10^{-8} A \epsilon (T_1^4 - T_2^4) \qquad (1)$$

where

R = the heat dissipated by radiation in Btu per hour.
ϵ = the emissivity of the surfaces or unity for both the surfaces of the clothed body and the walls for low temperature radiations.
A = the area of the human body effective in radiating heat, assumed to be 17 sq ft.
T_1 = the absolute temperature of the body surface assumed to be equivalent to an average of 75 F for the visible surface of the clothed body.
T_2 = the absolute temperature of the surrounding wall surfaces in view of the body.

Substituting these values in Equation 1 and assuming that the entire surrounding wall surface or a surface subtending a solid angle of 4π steradians is at air temperature of 70 F, a rate of heat dissipation by radiation of 101.4 Btu per hour is given. If all values remain the same as assumed, except that one sixth of the solid angle at the body is subtended by surfaces at 60 F instead of 70 F, the radiation loss will be 133.4 Btu per hour, or 32 per cent greater than in the warm wall room. While the value of the factors entering into the problem and therefore the numerical results cannot be offered as applying rigidly, they do serve to demonstrate the extent to which a change of 10 deg in only a part of the surrounding walls affects that part of the total heat loss which is dissipated by radiation, emphasizing the fact that the difference between the fourth powers of two numbers is much greater than that of the numbers themselves.

Since the feeling of comfort as regards warmth for a person seated at rest depends upon the balance between his rate of heat production and heat loss, any increase in heat dissipation by radiation must, to maintain the same feeling of warmth, be compensated for either by increased metabolism or by a corresponding decrease in the combined loss by evaporation and convection. If the metabolism remains constant, the required decrease in evaporation and convection may be brought about by increasing the air temperature. The purpose of the present study was to evaluate the cooling effect on a person because of excessive radiation of heat to the surfaces of walls at temperatures lower than the room air, and to determine the higher air temperature necessary to compensate for this excessive radiation loss.

Test Arrangements and Procedure

The study reported in this paper was made in the psychrometric chambers of the A. S. H. V. E. Research Laboratory located in the Pittsburgh Experiment Station of the United States Bureau of Mines. These chambers and the equipment for air conditioning them are described in other Laboratory reports.[3] The chambers as originally built and in which all the earlier Laboratory comfort studies were made are entirely surrounded by interior walls of heavy construction with 4-in. cork insulation. The exceedingly low conductances of these walls maintains their inside surface temperatures practically equal to the temperature of the air in the chamber after constant temperature conditions have been established.

For the study of the effect of radiation, a 5 ft by 6 ft test room, Fig. 1, whose wall temperatures could be controlled independently of the air temperature, was built in the second psychrometric chamber, with a door between it and the first psychrometric chamber, so that a person could pass quickly from the small test room into the first psychrometric chamber. These rooms are referred to as the test room and the control room, respectively. The walls of the test room were made of sheet-metal, painted on the inside with a light buff pigment paint.

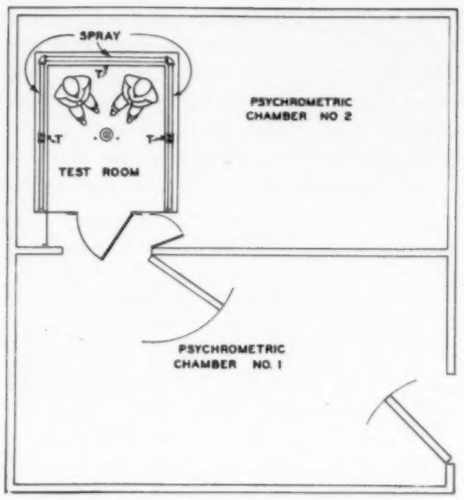

Fig. 1—Cold wall test room in psychrometric chamber No. 2

A vertical cross section of the test room which shows the auxiliary equipment for maintaining constant wall temperatures independently of the air temperature is shown in Fig. 2. Three of its sheet-metal walls were cooled by cold water sprays, but the fourth, containing the door, was not. Thermostatically controlled water was sprayed on the tops of the outside surfaces and made to flow in a uniform sheet down the entire area of the three sides of the room in sufficient volume to hold the inside surface temperature of the walls constant for the same elevation and to keep the difference in temperature between bottom and top within 0.5 deg. Thermocouple junctions for temperature measurements were attached to the center, at the top, and at the bottom on the inside surfaces of each of the three cold walls.

Air was admitted to the test room through the lattice work ceiling and left it through the lattice work floor. Screen baffles and resistances were so placed above the ceiling and below the floor that a uniformly distributed air flow was had throughout the room. Air was supplied from the air conditioning apparatus at desired temperatures and humidities in volumes that would give a suitable balance between velocity effect on the subjects and the fall in air temperature from ceiling to floor due to cold walls. A volume of 31,800 cfh was circulated, which for the unoccupied room with 50 F walls and 80 F entering air gave an air temperature drop of 5.5 deg from ceiling to floor. With other conditions the same, two subjects in the room reduced this temperature drop by approximately 0.7 deg. The calculated linear velocity through the cross section of the room necessary for 31,800 cfh of air passing was 26.5 fpm; however, the Kata thermometer reading gave an air velocity of 33.4 fpm. The difference between this velocity and 26.5 fpm as calculated should be accounted for by eddy currents. The Kata reading in the control room gave velocities ranging from 20 to 30 fpm.

Air temperatures at the 30-in. level in the center of the rooms were determined, both with and without occupants in the room, by a plain mercury thermometer and a shielded mercury thermometer. Temperatures were taken at the ceiling and the floor with shielded thermocouples, and at the 5-ft level the wet and dry-bulb temperatures were observed with a fan psychrometer. For any given setting of the air conditioning equipment, the wet and dry-bulb temperatures were observed with no occupants in the room, and the resulting moisture content applied to the changed condition in calculating the relative humidity of the occupied room at the 30-in. level. In order to avoid the effect of excessive air motion in close proximity to the subjects, the fan on the psychrometer was not run during occupancy.

The study, made from February to July, includes both the summer and winter seasons, but since the subjects were exposed to approximately the test conditions for at least two hours before observations were made, outside weather conditions should have little effect on the results. Three subjects participated in the study; however, because of the small volume of the test room, only two were allowed in it at a time. The tests were made with cold wall temperatures in the test room of 45 F, 50 F, and 60 F, with dry-bulb temperatures in the control room ranging up to approximately 80 F, and at varying relative humidities ranging from 20 to 80 per cent.

The individual tests on subjects were conducted in a manner similar to earlier tests[3] made in determining lines of equal warmth for persons under different conditions of activity, clothing, and the cooling effect of air velocities. The subjects went alternately from the test room to the control room, remaining seated ten minutes in each, while the temperature in the control room and the

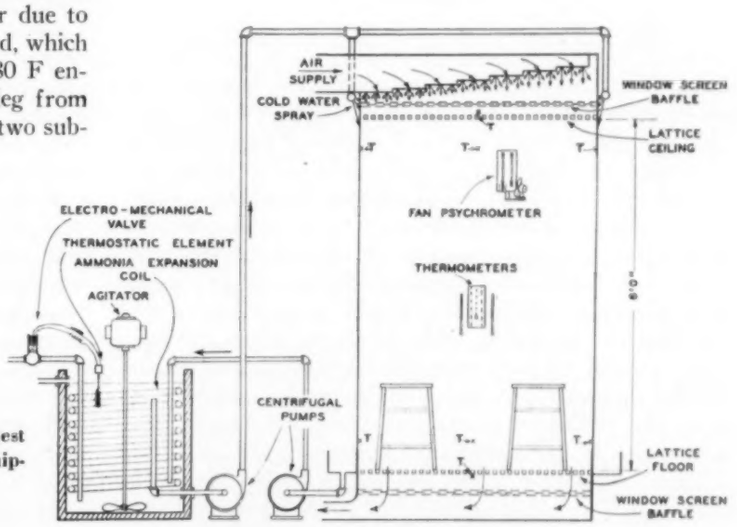

Fig. 2—Cold wall test room and control equipment

relative humidity in both rooms were kept constant the temperature and moisture content of the air in the test room were varied between successive visits to it. At the start of a test the conditions in the test room were set to make the subject feel decidedly cooler than he felt in the control room. While the subject made successive alternate visits in the two rooms, the temperature in the test room was gradually raised through the point where the subject expressed the same feeling of warmth in both rooms, and until he felt decidedly warmer in the test room. Thereupon the temperature in the test room was reduced in the same manner through the point of equal

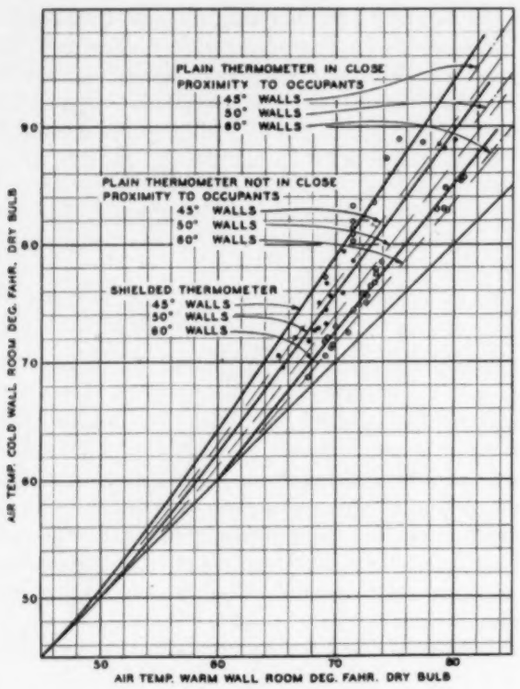

Fig. 3—Relation between dry-bulb air temperature in warm wall room and dry-bulb air temperature in cold wall room for same feeling of warmth. Temperatures at 30 in. above the floor indicated by shielded thermometer, plain thermometer not in close proximity to people, and plain thermometer in close proximity to people

warmth and back to where the subject felt colder in the test room than in the control room.

During the test the subjects analyzed and recorded their own individual feelings of warmth or coolness independently of each other and without knowledge of the change in atmospheric conditions. Their judgment concerning their relative feelings of warmth in the two rooms was expressed as *colder, slightly colder, same, slightly warmer,* or *warmer,* referring in each case to the test room in comparison with the control room. In any single test the dry-bulb temperatures as indicated by the shielded thermometers, were recorded when each subject reported a feeling of *same.* These temperature readings were taken as the temperatures required to give equal feelings of warmth in the two rooms under prevailing conditions. In analyzing the results, the number of degrees higher, expressed in degrees dry-bulb, which it was found necessary to maintain the air in the test room over that in the control room in order to give the subject the same feeling of warmth, or the number of degrees higher in temperature it was necessary to raise the air in the test room to compensate for the effect of the cold walls, was taken as the cooling effect of the cold walls on the subject.

Results

A number of curves giving the results of 51 tests according to individual reactions of the subjects are shown in Fig. 3, where the higher dry-bulb temperature in the test room is plotted against the dry-bulb temperature of the control room. In the studies made with test room walls at 45 F, 50 F, and 60 F, each respective cold wall temperature gives a band of points on the plot which fit the test data very well. The diagonal curve, representing equal temperatures in the test and control rooms, is also drawn. The number of degrees difference between the temperature indicated by this diagonal curve and the temperature of the test room, as given by the curve for each cold wall temperature, represents the cooling effect on a person for the particular wall temperature and the prevailing air temperature, or the number of degrees higher dry-bulb temperature which must be maintained in order to compensate for the excessive radiation loss to the cold walls of the test room.

The higher air temperature required to compensate for increased radiation loss in a cold wall room was expressed in deg dry-bulb instead of deg effective temperature for the reason that the effect is a function of the dry-bulb temperature of the air rather than of the effective temperature. The results of the study can be applied for any effective temperature by using the correction for the accompanying dry-bulb temperature in terms of effective temperature. Within the comfort zone, 1 deg change in the dry-bulb temperature of the air with no change in moisture content is equal to approximately 0.8 deg change in effective temperature.

The temperatures used as a basis for carrying on the study, as plotted in Fig. 3, are the shielded dry-bulb temperatures observed 30 in. above the floor in the center of the rooms. Considerable variation in observed temperatures can be had in a room where there is a marked difference between the air and wall temperatures, depending upon whether the thermometer used has a plain or blackened bulb which is exposed directly to radiation, or whether the plain thermometer is shielded. Occupancy also affects temperature as read by the various types of instruments.

With an 80 F air temperature as indicated by the shielded thermometer two occupants in the room and with the wall temperature 45 F, the exposed thermometer with the plain bulb located at approximately the same point indicated a temperature of 78.4 F, and the exposed thermometer with a blackened bulb a temperature of 78.3 F. With other conditions the same but without the two occupants in the test room, the shielded thermometer indicated a temperature of 79.4, and the plain thermometer 77.4 F. It will be noted that the effect of the blackened bulb as compared with a plain bulb in indicating temperatures is negligible. The several instruments

showed no measurable difference when located at the same point in the control room.

Shielding a thermometer reduces the effect of direct radiation between the instrument and the surrounding walls and objects. Such an instrument indicates very nearly the true dry-bulb temperature of the air at a particular point. Occupancy of the room has a two-fold effect on the temperature indicated by a thermometer: radiation from the surface of the clothed body raises the temperature of the bulb without raising the temperature of the air through which such radiation passes; and the occupants add sensible heat to the air, thus raising its true dry-bulb temperature. Hence, due to direct radiation from the subject, an unshielded thermometer when located in close proximity to a person registers a temperature higher than the true dry-bulb temperature of the air. A shielded thermometer, in an occupied room, however, indicates the true dry-bulb temperature of the air, so such temperature was accepted in this study as having the most practical significance.

Since room temperatures are usually measured with plain rather than shielded thermometers, it is of interest to consider the required temperature for comfort in a cold wall room as measured by a plain thermometer. Ordinarily, an unshielded thermometer is not placed as close to occupants as was necessary in the small test room, but rather far enough away to make the effect of radiation from the occupants negligible. In considering the desired temperatures in a cold wall room of normal size measured by an unshielded thermometer, it is more correct to consider the true temperature of the air as affected by the sensible heat from the occupants and radiation from the thermometer bulb to the cold walls, but not the effect of radiation from nearby occupants to the thermometer bulb. While such temperatures could not be read in the test room, they can be approximated by taking the temperature indicated by the plain thermometer in the unoccupied test room and correcting it for the true air temperature rise resulting from occupancy as indicated by the shielded thermometer. Curves based on this corrected temperature are shown in Fig. 3 as lightweight broken lines. The effect of the two occupants of the small test room on the temperature as indicated by the plain thermometer in close proximity to them is to give a higher temperature, though not as high a temperature as that indicated by the shielded thermometer. The relation between temperature in a cold wall room measured with a plain thermometer located in close proximity to two occupants and that for the same thermometer corrected for close proximity is given at the high temperatures by the short broken line sections of the curves.

The data presented in the curves in Fig. 3 are again plotted for the purpose of practical application in Figs. 4 and 5, where the correction to be made on the temperature in a cold wall room in order that it may produce the same feeling of warmth as that of a warm wall room is given for various wall and air temperatures. The corrections shown in Fig. 4 apply when the temperature is observed by a shielded thermometer, and those shown in Fig. 5 apply when the temperature is observed by a plain thermometer as generally used in practice; more particularly, it will apply in such rooms when the plain thermometer bulb is not close to any person. If the thermometer is in close proximity to persons, as between seated persons in a class room, theater, or audience hall, then the correction due to radiation from the occupants as indicated in Fig. 3 should be taken into consideration.

Relation of the Data Presented to Actual Conditions in Ventilating Practice

The effect which radiation to cold walls will have on the desired temperature for comfort will vary with every installation, due to the variation in the ratio of cold walls to the total area of walls, floor and ceiling, and to the variation in the solid angle subtended by these cold surfaces at points on the occupants.

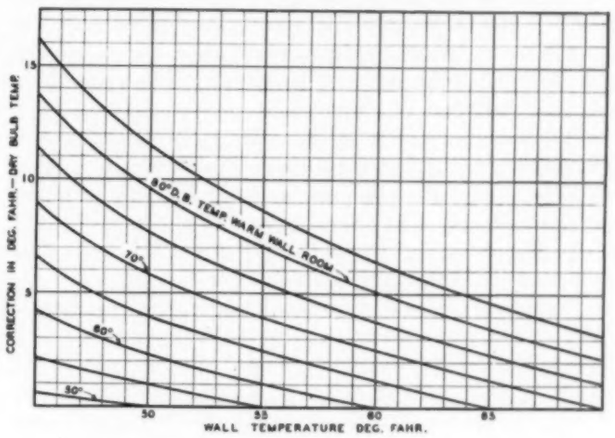

Fig. 4—Correction to various dry-bulb temperatures in a warm wall room for the same feeling of warmth in rooms having three cold walls. Temperatures indicated by shielded thermometers 30 in. above the floor

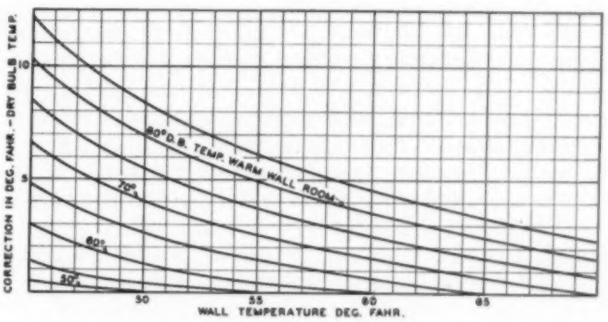

Fig. 5—Correction to various dry-bulb temperatures in a warm wall room for the same feeling of warmth in rooms having three cold walls. Temperatures indicated by plain thermometers, 30 in. above the floor, not in close proximity to occupants

It is believed that the conditions under which the tests were made exaggerate the results, because few rooms have three cold walls, most having but one exposure. Hence, the results here presented should be considered as greater than usually met with in practice. On the other hand, if an extreme case should be met with, such as a sheet-metal cottage with all walls and roof exposed, the radiation effect would be much greater than indicated by

test results; first, because of the greater effective area, and second because of the lower temperature which would pertain. Likewise, the effect of excessive window exposure may in special instances be greater. Window glass is ordinarily assumed to be opaque to low temperature radiation; therefore, the effect of a window should be the same as though it were a single thickness of sheet-metal. With zero F outside and assuming an outside film conductance of 5.6, an inside film conductance of 1.4, and 70 F air temperature indoors, the inside glass surface will be 12.9 F, which is much lower than the wall surface temperatures here studied. However, unless the glass area is excessively large, or unless the occupants are so close that the glass area subtends a large solid angle at points on their body surfaces, the effect will be comparatively small. Such conditions are so varied that it is obviously impossible in this paper to more than indicate their effect.

The close proximity of the subjects to the cold walls made necessary in the small test room may raise a question concerning the application of the findings to rooms of ordinary size. The effect which close proximity to the walls may have is two-fold; *first*, the solid angle subtended at the point of the occupant by the cold walls may be increased; *second*, downward convection currents of cold air near the cold walls may strike the subject.

The effect of close proximity of the subjects to the walls on heat loss by radiation depends only upon the change in the solid angle as discussed above, and since this depends upon both the distance from the wall and the size of the wall, this angle should not vary much as between the small test room and a room of ordinary size with the same proportion of cold walls in each.

A survey of temperatures in the horizontal plane at the 30-in. level showed a uniform temperature within plus or minus 0.5 deg, excepting for points distant 10 in. or less from the cold walls. Actually, a fall in temperature upon approaching the cold walls began at distances of approximately 15 in. At 10 in. from the wall this fall approximated 0.5 deg and increased as the wall surface was approached. The subjects were seated in the test room so that no part of their bodies was less than 12 in. from a cold wall surface. Hence, the cooling experienced in the small test room should not differ materially from like results for a larger room because of the closeness of the subjects to the walls.

During the study of the necessary compensating air temperature for cold walls, it was observed by the subjects that although they felt an overall sense of equal warmth in the test room to that experienced in the control room, local feelings of discomfort sometimes resulted for those parts of the body directly exposed to the cold walls having temperatures 50 F or lower. Discomfort might also result from a difference in temperature between the two sides of the subject's body and from his breathing air which is too warm. These experiences of local discomfort are common for a person seated near a large window in a warm room on a very cold day, unless a compensating radiant heat source is supplied from the same direction as the window. This is ordinarily taken care of in heating practice by placing a radiator under the window.

Since temperatures are observed ordinarily by plain mercury thermometers with bulb exposed to the same heat loss by radiation to the cold walls as are the surfaces of the clothed body, it might be assumed that the thermometer would automatically compensate for the greater heat loss by indicating an air temperature lower than that actually existing, so that when the thermometer indicates the desired temperature as given by the comfort zone, a true air temperature enough higher to compensate for the cold wall effect will result. The data obtained indicate that this is not entirely true, although the difference in temperature observed by the plain and shielded thermometers indicates some compensation in this direction. The reason for lack of complete compensation must lie in the difference in the surface area, the emissivity, the absolute temperature, or some combination of these existing between the thermometer bulb and the clothed body.

Conclusions

1. Increased radiation of heat from occupants in a room to cold walls on three sides is shown to require a higher air temperature for the same feeling of warmth. For example, an air temperature of 70 F with walls at the same temperature is equivalent to an air temperature 8.9 deg higher in a room having three of the four walls at 45 F. This effect is greater than usually occurs in practice for two reasons; *first*, few rooms have three exposed walls, and *second*, inside wall surface temperatures for reasonably good construction do not reach such low values for normal outside temperatures.

2. It is shown that in a cold wall room observed temperatures by mercury thermometers may vary depending on whether the bulb is shielded from or exposed to the *view* of the cold walls and of occupants.

3. Walls of large area having a considerably lower temperature than the surrounding air give a feeling of discomfort to occupants seated nearby due to the resulting feeling of coldness in those parts of the body exposed to the cold walls, even though the room air temperature is high enough to give an overall sense of not being cold. This is particularly true of large windows without a compensating radiator nearby.

Bibliography

1. Thermal Exchanges Between The Human Body and Its Atmospheric Environment, by F. C. Houghten, W. W. Teague, W. E. Miller, and W. P. Yant. (*American Journal of Physiology*, Vol. 88, No. 3, April, 1929.)

2. Heat and Moisture Losses From The Human Body and Their Relation To Air Conditioning Problems, by F. C. Houghten, W. W. Teague, W. E. Miller, and W. P. Yant. (A. S. H. V. E. TRANSACTIONS, Vol. 35, 1929, p. 245.)

3. Determining Lines of Equal Comfort, by F. C. Houghten and C. P. Yagloglou. (A. S. H. V. E. TRANSACTIONS, Vol. 29, 1923, p. 361.)

Carbon Dioxide

Carbon dioxide at ordinary concentrations is not harmful. The amount of carbon dioxide in the air is a convenient index of the distribution of the air within large rooms. In determining the amount of carbon dioxide in the air, the customary procedure is to record the initial volume of the air and then to absorb the contained carbon dioxide in a caustic potash solution, and finally to remeasure the volume of air at the original pressure in a finely graduated capillary tube. The difference in volume represents the absorbed carbon dioxide.

Cow Barn Ventilation

By **Alfred J. Offner,* New York, N. Y.** ***(MEMBER)***

THE principles, applications and details of cow barn ventilation differ from the ventilation of buildings used for human occupancy. A collection, digest and review of available information, both from technical and manufacturers' sources should therefore be of interest.

The Cow

All domesticated cattle in the United States are of European origin, of the *genus Bos, Bos taurus* being the dominant species. The historic background and climatic adaptability of the cow indicate that she is a native of cold regions. When well fed and properly housed, cows enjoy and thrive in cold climates. For these reasons, the principal dairy areas of the world are confined to the colder sections, although dairying is gradually assuming more importance in California and the South.

The domesticated cow has existed since recorded time. The earliest written known records, including the Old Testament of the Bible, refer to cattle. The cow of today is therefore a creature of environment unnatural to her and of habits acquired through her long contact with man.

The size of the cow varies with the species, ranging from the smallest, the Kerry cattle of Ireland averaging 400 lb in weight, to the largest, the Great Shorthorns, whose show bulls and steers have attained weights as high as 2,500 lb. When full grown, the males are always the larger and weigh about 50 per cent more than the females of the same breed.

Breeds of cattle are usually classified into three groups, according to their functions and use, namely, (1) the specific beef group, raised for their meat production; (2) the special milk group, for their milk yield; and (3) the general or dual-purpose group, used for both meat and milk production.

Of the approximately 20 breeds of cattle found on American farms, only nine can be classed as of importance so far as general use and number are concerned. The four supreme breeds in the special beef group are the Shorthorn, Hereford, Aberdeen-Angus, and Galloway. In the special dairy group, the five important breeds, together with the average weights for full grown cows, are Holstein, 1,250 lb, Jersey, 850 lb, Guernsey, 1,050 lb, Ayrshire 1,100 lb, and Brown Swiss, 1,200 lb. These vary in the amount of milk and percentage of butter fat produced.

Need of Ventilation

To one not entirely familiar with modern dairy management, equipment and care, the question might arise as to the necessity of artificial ventilation of cow barns. Modern dairy practice shows that at outside temperatures below 50 F, milk production is affected. While 50 F is not the minimum allowable barn temperature, it is generally customary to start to stable cows when the temperature during the night is likely to drop below that temperature. With outside temperatures above 32 F, barn windows and doors may be kept partly open, but at temperatures below freezing they must be closed and the ventilating system operated at full capacity. During extremely cold weather, the amount of ventilation may be somewhat curtailed to conserve heat in the barn.

The old-fashioned barn—with its ineffective, if not entirely lacking ventilating system, insufficient or improper window sizes and locations which retarded the entry of the health-giving sun, with damp and dripping walls, floors and ceilings, foul smelling and unsanitary—resulted not only in curtailed milk production, but encouraged pneumonia, pleurisy, and tubercular cows. Such barns, especially where commercial, have long been outlawed in the interests of public health. To remove the moist and foul air and disagreeable odors necessitates a properly-designed, controlled, and continuously-operated ventilating system.

The purpose of a barn ventilating system is not only the removal of moisture and odors, but also the supplying of the necessary amount of *fresh* air required for the needs of the cows. A producing cow needs an abundant supply of *fresh* air, especially when under the increased feeding necessary for greater output of milk or for increase in weight. She needs this *fresh* air to digest and assimilate her food and produce animal heat, to repair and build up body tissues, and to make a plentiful supply of milk.

To have and to retain healthy stock requires sanitary living quarters, proper and well-balanced rations of food and water, and an abundant supply of fresh air free of drafts. Vitality is the quality that makes milk records. Inadequate ventilation will reduce the vitality of cows and make them more liable to disease. Insufficient ventilation is also one of the principal causes of smelly barns with damp and dripping walls and ceilings.

Amount of Ventilation

The problem of ventilating cow barn buildings differs from that of ventilating buildings used for human occupancy in that the spaces to be ventilated have higher relative humidities with comparatively low air temperatures.

Excepting so far as air volume and consequently building exposure area per head of cattle affect temperature, large cubical air content of a barn does not determine the purity of the air. Continual air changes and movement are necessary. As the loss of heat from the body of the cow by evaporation is affected by both the temperature and relative humidity of the surrounding air, the amount of ventilation not only affects the

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For presentation at the 39th Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Cincinnati, Ohio, January, 1933.

rate of removal of moisture, but also the rate at which moisture is produced.

The air in a barn is vitiated by the animal excrement, odors of certain feeds, and the products of respiration. Odors detected in the milk are not always caused by the feed, but may be absorbed from the contaminated air in the barn. A successful barn ventilating system is therefore one which continuously supplies the proper amount of air required by the stock, with proper distribution and without drafts, and removes the excessive heat, moisture and odors, thus maintaining the air at the proper temperature, relative humidity, and degree of cleanliness. As with humans, the physical comfort of stabled cattle depends upon the temperature, humidity and air motion.

The original air quantity standard proposed by the late Professor King[1] was based on the amount of pure air which had to be breathed by one cow, and on a standard of air purity recommended by him. His computations gave 117 cfh as the amount of air required by a cow averaging 1,000 lb in weight, and his recommended standard required a purity of the air in the barn of 96.7 per cent, that is, the air in the stable was not to contain more than 3.3 per cent of the air once breathed. This gave 3,542 cfh of air as the amount of ventilation required by one cow weighing 1,000 lb. As air expired from the lungs contains 4.24 per cent by volume of carbon dioxide, and pure air 0.028 per cent by volume, King's standard would allow $4.24 \times 0.033 + 0.028 \times 0.967$, or 0.167 per cent by volume of carbon dioxide. Armsby and Kriss[2] suggest that the amount of air to be supplied per cow is more correctly 3,452 cfh.

In determining these two standard ventilating air quantities based on CO_2 production, little consideration was given to the air temperatures and relative humidities. M. A. R. Kelley,[3] basing his calculations on air temperatures and relative humidities, states that 2,700 cfh of air per cow would be sufficient to remove the average production of 4,375 grains of moisture given off by a cow producing 20 lb of milk per day. His calculations are based on an outside temperature of 32 F and a relative humidity of 85 per cent and a barn temperature of 53 F and a relative humidity of 75 per cent.

Strahan[6] proposes the following values for volume of air flow in cubic feet per hour per cow. These values are also based on air temperature and humidity control, but in addition, consider the variation in minimum outside temperatures found in the different dairy zones:

Zone	Normal	Restricted	Theoretical Required to Prevent Condensation
1	2600	2000	2163
2	3175	2600	2225
3	3550	3000	2225

The normal amount of ventilation proposed is based on the daily mean temperature obtained in each zone. (See table of temperatures for January and February.) When the outside temperature falls below this daily mean, the amount of ventilation must be restricted so that the thermal balance is maintained.

1. Numeric references refer to Bibliography.

Temperature of Barns

Nature provides such birds and animals which do not migrate to warmer climates on the approach of cold weather with more feathers or a more abundant and longer hair growth as a protection against the cold. Therefore, when stabling animals which part of the time are outdoors, too much of a variation between the two temperatures should not occur. The vitality of cows is reduced when they are kept in barns that are too warm.

The comfort and condition of a cow affects her milk production. As an increase in milk production requires an increase in feeding, the barn temperature should be low to induce the cows to eat more, but not so low that food is wasted for production of unnecessary body warmth.

While a barn that is *too cold* reduces milk production and consequently results in a waste of feed, a barn that is *too warm* will cause a loss in appetite and a corresponding decrease in milk production. The amount of milk produced is further affected by sudden changes in temperature. A cow barn should be at a temperature high enough to prevent the freezing of the water in the drinking cups and provide comfort for the men working in the barn. Furthermore, the temperature should be high enough to permit the supplying of the required amount of fresh air during cold weather without producing discomfort to the animals.

Investigation shows that barn temperatures below freezing and above 80 F affect the milk production, decreasing both the quantity and quality of the milk. Animal comfort does not require high barn temperatures. Barns containing milk-producing stock should be kept at a temperature between 45 and 50 F. For dry stock, when at reduced feeding, the barn may be 5 to 10 deg higher. Calf barns are generally kept at 60 F, while hospital and maternity barns have a temperature of 60 F or somewhat higher.

Animal Heat

Food is the source of animal heat. The heat therefore given off by a living being depends on the amount of food consumed and the efficiency with which the heat generated is conserved. Armsby and Moulton[4] state that a dairy cow uses about 70 per cent of the combustible food energy absorbed. Knowing the amount of food consumed in a given time and its calorific value, the amount of heat produced by a cow can be estimated. The heat produced by the food must then be equal to that used for body gain (flesh, fat and milk), plus all the heat losses from the body.

The heat from the body is lost through respiration, by elimination, and by losses from the skin by evaporation, radiation and convection. Howell[5] quotes Vierordt as estimating the total heat losses from the body as follows:

Urine and feces	1.8%
Expired Air	
Warming of Air	3.5%
Vaporization of Water from Lungs	7.2%
Evaporation from Skin	14.5%
Radiation and Convection from Skin	73.0%
	100.0%

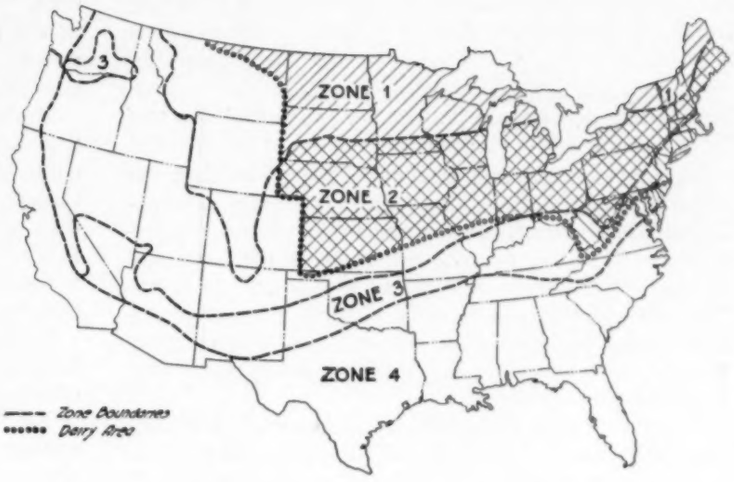

Fig. 1—Climatic Zones of the United States

From the foregoing figures it will be noted that with the exception of the first item, about 98 per cent of the total heat given off by the body is affected by the thermal conditions of the surrounding air. Hence the importance of temperature, humidity and air movement in producing body comfort.

The amount of food consumption does not only vary among the different species, but also varies among animals of the same kind. As is noted in humans, the amount of food actually required varies with the age, sex, weight, temperament, physical conditions, and the physical and digestive activity of the individual. The thermal conditions of the surrounding air also has its effect on the appetite. Other things being equal, an increase in weight or physical activity should increase the amount of food consumed.

It has even been found that the posture of an animal has its effect on the amount of heat produced. For example, a standing animal, due to the greater muscular activity, gives off more heat than an animal lying down. Kelley[5] has found that with cows this increase in heat production is sufficient to raise the barn temperature, under average conditions, 1 to 2 deg in one half hour, this increase in temperature being most noticeable in the morning after the cows stood up.

To estimate the heat production of various farm animals under normal conditions, Rameaux's Law may be used. This law states that in animals of the same species the calorification is proportional to the cutaneous (*i. e.*, skin) surface and to the cube root of the square of the weight of the body, together with the use of a suitable constant.

Allowable Barn Cubage

The design of a cow-barn building to be located in a cold climate so far as thermal conditions are concerned differs from a building designed for human occupancy in that for the former the heat available is fixed by the size and number of animals to be stabled, while in the latter the source of heat is variable and can be sized to properly take care of the given conditions.

The air temperature of a cow barn is the resultant of the heat generated by the stabled animals and the heat lost from the barn through the barn structure, plus the heat used by the ventilating system. The cubical contents of a barn that can be heated and maintained at the desired air temperature by the stabled animals therefore depends on the animal heat produced and the heat losses just mentioned. Consideration must also be given to the actual space required for stabling the animals, including that required for the feed and litter alleys. The size of a stall depends on the breed of cow to be housed. For an average cow, a 3½ ft wide and 9 ft long (which allows for manger and gutter) stall should be provided. Feed alleys should be not less than 4½ ft wide, while litter alleys require a minimum width of 5 ft. In barns having two rows of cows facing in, the common feed alley should be not less than 6½ ft. Where the cows face out, the common litter alley is made 7 ft wide. Allowing for necessary feed and litter carriers, the height of the barn should be at least 8 ft. Accordingly, the minimum floor space required by a cow is 60 sq ft and the minimum cubage nearly 500 cu ft.

Under conditions where the lowest outside temperature is never under 32 F, the volume of barn air space permissible per cow need not be considered so far as barn air temperature is concerned. Where the outside temperatures drop below freezing, animal heat must be conserved and the question of permissible volume of barn space and therefore the area of the building exposure subject to heat losses must be considered.

The amount of heat produced by a dairy cow varies with her size and condition of lactation. A small cow in low milk flow averages 2,700 Btu per hour, while a large cow with heavy milk flow may give off as high as 3,700 Btu per hour. Approximately 75 per cent of this heat is available for warming the barn, the remainder being in the form of latent heat.[6] The heat produced by a cow of an average weight of 1,000 lb may be taken as 3,000 Btu per hour.[3] The heat produced by a cow of a different weight, according to Rameaux's law, varies in proportion to the two-thirds power of the weight, and therefore can be calculated. For example, a heifer weighing 500 lb would produce 1,820 Btu per hour. The weight of calves of course varies with the age, but it can be assumed that the heat production of three calves averaging six months in age is equivalent to that produced by one cow of average weight, while two yearlings are about equal to one cow.

Fig. 1 prepared by the United States Department of Agriculture, shows the climatic zones of the United States. It is based on the recorded average temperatures for the months of January and February over a period of 30 years at 100 selected stations. The principal dairy area is confined to Zones Nos. 1, 2 and part of No. 3, from and including the Dakotas east to the Atlantic coast. The daily mean temperature at 8:00 a. m. for the months of January and February and the

average temperature for these months for the various zones are given in the following table:[3]

	ZONES			
For January-February	1	2	3	4
Daily Mean Temp (8:00 a.m.)	5 F	17 F	27 F	36 F
Monthly Mean Temp	11 F	22 F	30 F	over 32 F

The average extreme is about 20 deg less than the monthly mean temperature. Due not only to varying outside temperatures, but also to differences in opinions and practice, the number of days the cows are stabled varies widely in different sections of the country. As cows should be stabled when the night temperature is likely to drop below 50 F, this temperature may be taken as a basis for determining the average length of the stabling season.

From the equivalent number of head of stock, the total heat that will be produced within the barn can be figured. Knowing this and the average number of days the cows are to be stabled, the number of cubic feet of air space per cow can be calculated from the following formula:[3]

$$V = \frac{H \times k}{D} \qquad (1)$$

where

H=the heat in Btu per hour given off by one cow equal in weight to the average of all the cows in the barn,
D=the average number of barn days per year,
k=a constant, which for well constructed barns is taken as 60,
V=the volume of air space, in cubic feet, that can be kept at a comfortable temperature by one cow and therefore allowable per head of stock.

For barns in locations having unusual outside temperatures, either lower or higher than the average, D in Formula 1 may be replaced by $300\text{-}5T$, in which T is the mean temperature in degrees Fahrenheit for the month of January. The formula then becomes,

$$V = \frac{H \times k}{300 - 5T} \qquad (2)$$

Based on assumed average numbers of barn days per year of 300, 250 and 240, and a mean of 3,000 Btu per hour emitted by a cow averaging 1,000 lb in weight, the permissible barn volume per cow for Zone No. 1 would be 600 cu ft; for Zone No. 2, 700 cu ft; and for Zone No. 3, 750 cu ft. These figures, theoretically, may therefore be used, providing the heat losses through the structure are not so high as to upset the heat balance. Barns having the permissible cubage but not fully stabled or having building heat transmission losses greater than permitted, require either additional insulation or even artificial heating.

Kelley[3] has demonstrated by test that in a well-built barn, fully stabled and with an air cubage equal to that allowed for the outside temperature, it is possible to obtain a temperature of 40 F even when the outside temperature is as low as —30 F.

Humidity of the Barn Air

The increase in the amount of moisture found in barns over that present in the incoming air, is caused by the stabled animals. In cows, the principal source of moisture is from respiration and not evaporation. The cow does not possess sweat glands to the same extent as do human beings, these glands being mostly in their nose. The total amount of moisture or absolute humidity in the barn air therefore depends on the number and size of the animals housed, on the humidity of the incoming air, and amount of ventilation obtained.

With a fixed amount of moisture produced in a barn that is well and properly constructed, theoretically the absolute humidity of the barn air should vary with the amount of ventilation provided. In actual practice this does not exactly hold, as unaccountable leakage will affect this relation, but to a certain extent the amount of moisture can be controlled by intelligent operation of the ventilating system.

With the amount of moisture constant, the relative humidity of course varies with the air temperature, decreasing in percentage as the air temperature rises. It is therefore possible to remove barn air moisture with outside air having a high relative humidity, even saturation, providing of course that the outside temperature is lower than that of the barn. Under average weather conditions, the mean relative humidity for the month of January is found to be 85 per cent.

Armsby & Kriss[2] give as the average rate of moisture produced by a cow giving 20 lb of milk per day, as 15 lb of water per day, or 4,375 grains per hour. To prevent an increase in the moisture contents of the barn air, 4,375 grains of water must therefore be removed per hour by means of the ventilating system.

To set a standard of permissible relative humidity for cow barns is difficult, as such a standard is affected by so many variable factors requiring consideration. Kelley[3] suggests for a stable temperature of 45 F an average relative humidity of 80 per cent as being satisfactory, with an 85 per cent relative humidity as a limit not to be exceeded. Tests made by him show that it is not difficult to obtain this suggested standard, providing other conditions are favorable. With a barn temperature of 53 F, a relative humidity of 75 per cent can and should be maintained.

Condensation: Drip and Protection Against Same

Damp and dripping barn ceilings and walls may be caused by insufficient and improper ventilation, poor and leaky barn construction, insufficient production of animal heat, too great loss of heat through barn structure or through lack of necessary building insulation. Air movement over the barn ceiling and wall surfaces affects the amount of condensation removed, the higher the air velocity, the greater the moisture removed and the less chance for condensation and drip to occur.

Cracks in otherwise well constructed barns, or in the insulation itself, will present points at which condensation and drip may occur. In ceilings constructed of wooden beams, forming an air space, care must be taken to prevent the circulation of cold air through same, otherwise condensation and drip is apt to occur on the ceiling below.

Obstruction to the free and unrestricted flow of the air caused by building projections, such as beams, presents the possibility of condensation and drip forming at these points. This is caused by the creating of pockets of non-moving air. Therefore, from a ventilating standpoint, the interiors of cow barns should be as free as possible of all building obstructions and projections.

On account of the high relative humidities and low air temperatures encountered in cow barn work, it is not always possible entirely to eliminate the forming of frost in ventilating ducts and flues. To reduce this to a minimum, both supply and exhaust ventilating ducts and flues located in outside walls or passing through cold spaces must be insulated and made air tight to prevent condensation and drip. Air leakage in gravity exhaust flues will of course also affect the efficiency of such flues, and reduce the amount of air handled. The lower parts of horizontal ducts and also the vertical ducts, where excessive condensation might occur, should be made water tight by soldering.

Types of Ventilating Systems

Agricultural authorities generally agree that artificial ventilation is necessary for cow barns, but they differ as how to apply the ventilating system. While they agree that the air is not to be heated and that it be supplied through or at the ceiling, there is a difference of opinion as to whether the air should be exhausted from the ceiling or near the floor. Among manufacturers of farm building ventilating equipment there is a distinct and clear division between the two types, one strongly recommending bottom exhaust, while another with equal sincerity recommends the use of top exhaust. Therefore cow-barn natural-draft ventilation may in general be divided into two types, namely (1) top supply—bottom exhaust, and (2) top supply—top exhaust.

The first type of natural draft ventilating system, based on the theories of Professor King and known as the *King System,* supplies the air through the ceiling, generally along the center line of the barn, and exhausts the air from near the floor along both outside walls of the barn. With this type of system, it is customary to provide occasional ceiling openings, called heat doors, which are opened in warmer weather to permit the escape of excessive heat from the barn.

The second type, known as the *Rutherford type* of ventilation, originally supplied the air along the outside walls near the floor and exhausted the air through the ceiling in two rows, each row being located about one quarter of the width of the barn from the outside walls. A modification of this type, known as the *Modified Rutherford System,* supplies the air in the same manner as the King System, namely through the ceiling along the center line of the barn, but the air is exhausted through the ceiling near and along both outside walls of the barn.

Top Versus Bottom Exhaust

A movement of air, and consequently ventilation, will be obtained whether bottom or top exhaust is used. There may be certain conditions or results desired, making the use of one or the other type more desirable.

The air does not pass direct from the intake to outlet but, due to the heat radiating surfaces presented by the bodies of the cows, convection currents are generated, causing a swirling and mixing of the fresh and barn air.

Under general conditions, the air temperature at the ceiling of a barn may vary up to 10 deg higher than the temperature at the floor. Therefore, when the air is removed from near the floor the mean barn temperature would be higher than when the air is exhausted at the ceiling. This is borne out by the results of a number of independent tests which show that with bottom exhaust, other things being equal, higher and more uniform barn air temperatures are obtained, with increase in ventilation and reduced relative humidity. With types of ventilating systems having ceiling exhaust only, it is necessary during extremely cold weather to reduce the amount of ventilation so as to conserve the animal heat and prevent the barn temperature from dropping below the comfort point. With the exhaust openings located near the floor, larger volumes of warm air are held in the barn, resulting in better temperature control and less likelihood of sudden change in barn temperature.

Gravity and Fan Exhaust

The air supply required for barn ventilation is introduced into the building by temperature differential and wind pressure. The majority of air exhaust systems are also of the gravity circulation type, with the occasional use of an electrically-driven fan.

The amount of air moved in a gravity system is affected by the temperature differential and by wind

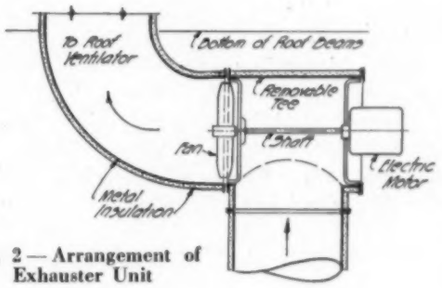

Fig. 2 — Arrangement of Exhauster Unit

action. A ventilating system designed for a certain air movement, based on certain thermal conditions, will not handle the desired amount of air when the temperature difference varies from that assumed. A fan operated exhaust system will overcome this difficulty and permit the moving of the desired amount of air, unaffected by temperature difference or wind.

The kind of exhaust fan generally used is of the disc or propeller type, with direct-connected electric motor. Electric motors should be totally enclosed as a protection against dust and moisture.

With either top or bottom exhaust discharging through roof ventilators, the exhauster unit is generally placed near the base of the ventilator. Fig. 2 illustrates such an arrangement.

Exhaust fans may be placed directly in the barn, exhausting either from the floor or ceiling and discharging through the barn wall. Hood and automatic louver protection should be provided on such air discharges.

Another type of exhauster unit, applicable to top exhaust, places the unit at the ceiling where usually the exhaust register or opening is located. Such an arrangement permits either gravity or mechanical operation of the exhaust ventilating system.

Air Intakes

The incoming air may be supplied to a barn either by means of windows or through wall and ceiling openings, the last two controlled either by hand or automatically.

Windows may be used as air intakes in the warmer zones of the country where freezing does not occur. They may also be used in colder climates as a supplement to the regular air intakes, when the outside temperature is higher than 32 F and an increase in the amount of air supply will not affect the barn air temperature so far as comfort is concerned. Their use in cold climates is not desired as they will frost and drip, and they also require frequent adjustment and control for air temperatures and air quantities.

Air intakes located on the exterior of buildings should be provided with hoods, louvers, or other means permitting the air to enter freely, but excluding rain and snow. Furthermore, such openings should be protected by wire screens to prevent the entry of leaves, birds, rats, etc. Wire mesh smaller than ½ in. should not be used, as such screens clog up easily.

Under certain conditions, back drafting or reversing of the direction of the air flow will occur in the fresh air intakes. This may be caused by any of the following: by through draft, when intakes are located on opposite sides of the barn; when the air intake is on the leeward side of the barn, caused by change in wind direction and intensity; or when the air intake is located near the corner of the building or in locations where projections of adjoining buildings might deflect the wind direction. Kelley[3] states that back drafting will occur in wall intakes 6 ft or more in length at a wind velocity of 6 mph and with window intakes at 3 mph or even less.

Back drafting in air intakes may be partly overcome by lengthening the duct connection or by offsetting the duct in a vertical direction so that the exterior and interior openings are not opposite each other. Such arrangements will slightly decrease the air delivery due to the additional resistance introduced to the flow.

To completely overcome back drafting, back pressure dampers are used, which operate by the air current and automatically prevent the flow of the air out of the building. These dampers must be constructed of light and rust resisting material, such as aluminum, and should be free and easy swinging. They generally are placed in an angle frame and the edges of the dampers are provided with felt to reduce the striking sound and to prevent air leakage when the damper is closed. Fig. 5 shows such a damper swinging on a horizontal axis, while Fig. 6 indicates one having a vertical axis.

Figs. 3, 4, and 5 illustrate three different general types of wall air inlets and are self explanatory. It should be noted that each type is entirely insulated to prevent condensation and drip in these connections. Fig. 6 shows a type where the air is introduced into the barn through the ceiling, the outside air being taken through any convenient opening located within a reasonable distance away, as a louvered dormer window. Several of these ceiling inlets may be combined and supplied from a common air intake.

Air Exhausts

The exhausted air is generally collected and discharged at the ridge of the roof through suitable ventilators. These roof ventilators may be of wood, having louvered and screened openings on all sides. If of metal, they generally are of the circular type. Fig. 7 shows a typical arrangement of such a ventilator. Ventilators of the revolving type are sometimes used to accelerate the air movement by means of wind action. Such parts of the ventilator which are located within the building should be insulated.

Where the space over the barn is used for the storing of hay, vent openings should be placed at the base of the ventilator, to exhaust the air from the hay mow during the warm weather or when the hay is fresh and has just been stored and gases are likely to be formed. A movement of air will also prevent rotting of the hay should it become wet. Such hay-loft vent openings will reduce the amount of air exhausted from the barn proper. They should be kept closed in extremely cold weather as they are not needed or desired at that time. The mixing of the warm barn air with the comparatively cold air from the hay loft will cause condensation, with the possibility of the roof rafters around the ventilators rottening.

The use of hay and feed chutes for exhausting the barn air is undesirable as such an arrangement will

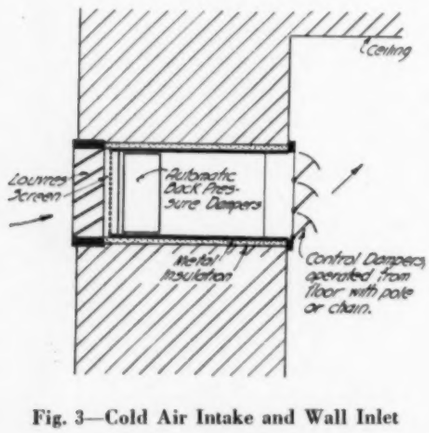

Fig. 3—Cold Air Intake and Wall Inlet

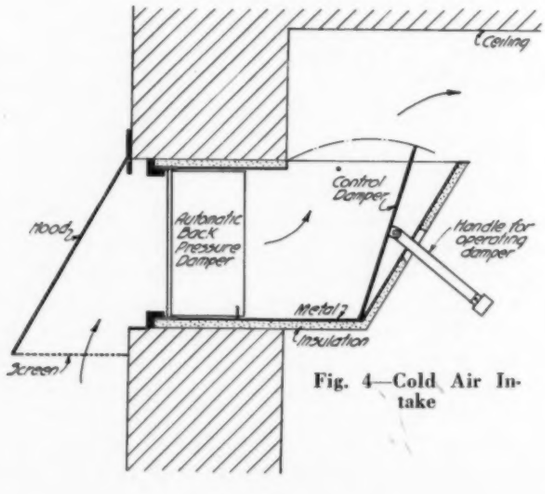

Fig. 4—Cold Air Intake

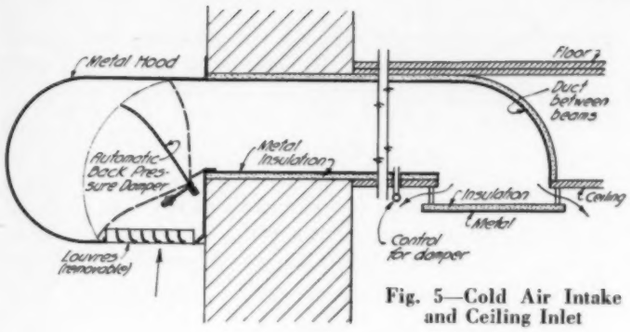

Fig. 5—Cold Air Intake and Ceiling Inlet

upset the operation and control of the ventilating system. If air exhaust outtakes are properly located and arranged, no back drafting will occur and therefore no back pressure dampers are required in such connections.

Kind of Materials Used

In cold sections, the use of wood, even when insulated, is not recommended as such flues are not entirely free of condensation. The alternate wetting and drying of the wood would eventually rot it.

Flues other than wood should be of rust-resisting metals or some other kind of waterproof material. For metal, heavy galvanized iron, copper bearing galvanized iron, or copper are used.

All parts of the ventilating system exposed to the weather or where condensation may form, such as ventilators, wire screens, dampers, etc., should also be of heavy and rust resisting material.

Hand and Automatic Control

Each air supply and each air exhaust opening should be provided with friction dampers which can be placed at any degree of opening and be conveniently operated from the floor of the barn.

Automatic control systems have been developed and used in cow barn ventilation work. While such devices will control a system for the results for which the automatic regulators are set the setting and adjustment of them depend on the attention, judgment and experience of the attendant.

The damper on the exhaust outlet of a gravity system may be automatically controlled by a self-contained regulator, such as a bellows and weighted lever, adjustable for varying air temperatures. Dampers may also be controlled by electric or pneumatically-operated automatic controls actuated by thermostats located either in the barn proper or in the exhaust ducts. Where mechanical exhaust is used, the automatic control system would operate the exhaust fan motors.

Barn Construction and Insulation

The proper ventilation of the barn in cold weather is of major importance. Hence the heat losses through the structure proper should be reduced to a minimum so that as much as possible of the animal heat available may be used for tempering the incoming air, assuring maximum ventilation.

Barns should be of tight construction to prevent excessive leakage of air. Doors should always be of double thickness, the plys running across each other to prevent warping and buckling. In extremely cold climates, vestibules or storm doors are desirable. In such locations, storm sashes should be used on all windows to prevent excessive heat losses and the forming of condensation and drip. Single glass windows therefore should not be used. Due to low resistance to the flow of heat, single glass will frost easily, retarding the sanitary and heating effects of the entering sunlight.

Even in well-constructed barns, in which the heat transmission losses are within the allowable limit, care must be taken in building design and construction to prevent the introduction of structural parts which will present low heat resistance. For example, along a concealed steel beam, which material is a good conductor of heat, the flange might be too close to the wall or ceiling surface, permitting condensation and drip to form at those points. In such cases, insulation must be provided to those parts. Silo, hay chute and other utility openings must be fitted with doors which can be closed air tight.

The necessity of insulation depends on a number of factors, such as outside temperature, the efficiency of the barn construction against the loss of heat, the lowest barn temperature, highest humidity, and the least amount of ventilation desired. Insulation is also indicated where the air cubage of the barn is greater than can be comfortably heated by the housed animals, or in barns where, although the air cubage is within the permissible limit,

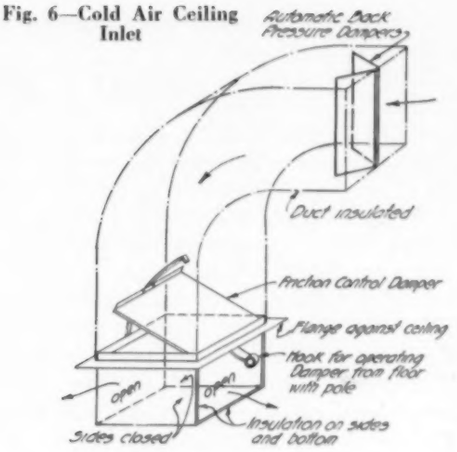

Fig. 6—Cold Air Ceiling Inlet

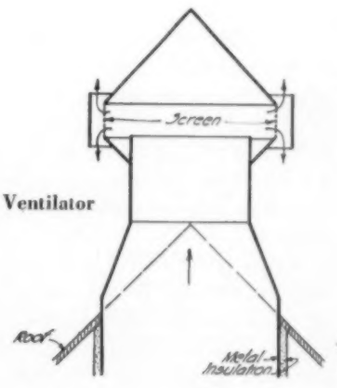

Fig. 7—Roof Ventilator

it is known or expected that at certain times the barn will not be fully stabled.

While it would be possible, to a limited extent, to increase the air temperature of a barn not properly constructed or insulated, by increased feeding, such procedure would not be economical in cost. The application of the required insulation is the better investment.

As the ceiling is not only at a higher temperature but generally has a lower heat resistance than the wall construction, special consideration as to the necessity of insulation should be given to this part of the barn. Where a ceiling is provided, thus covering the beams, the ceiling should be insulated as the space between the beams will get cold enough to cause condensation on an uninsulated ceiling. When the beams are exposed and the space over the barn is used for hay storage, the barn ceiling would be well protected against heat losses and no insulation would be necessary. But care must be taken in cold weather that all the hay is not removed from the hay loft floor, leaving it bare, as condensation may form on that part of the barn ceiling located below.

The efficiency and structural strength of the insulation to be used is of great importance. Consideration must also be given as to the effect of moisture on the insulating material, that it is fireproof, and that it will not harbor vermin, etc.

Permissible Building Heat Losses

The permissible heat loss through the barn structure depends upon the outside and inside temperatures, the available animal heat, the amount of ventilation desired, and the area of building exposure. For Zone No. 1, based on one cow, assuming 2,600 cfh of air for ventilation, 45 F barn temperature, 5 F outside temperature, and an available heat of 3,000 Btu (1,000 lb cow), the heat required for ventilation would be $2{,}600 \times 0.019 \times (45 - 5) = 1{,}976$ Btu. To maintain the desired barn temperature and amount of ventilation, the maximum amount of heat that can be lost through the barn structure is then $3{,}000 - 1{,}960 = 1{,}024$ Btu per hour for a 40 deg difference, or 25.6 Btu for a 1 deg difference. A typical barn having 600 cu ft of space per cow would have about 130 sq ft of building exposure permitting heat losses, such as walls, windows, doors, ceiling and part of floor. On this basis, the permissible heat loss per hour per cow, for a 1 deg difference, would be 0.043 Btu per cubic foot, or 0.197 Btu per square foot of exposure.

For Zone No. 2, based on 3,175 cu ft of air, a 50-F barn temperature, and a 17-F outside temperature, the permissible heat loss for a 1 deg difference would be 0.051 Btu per cubic foot and 0.235 per square foot. For Zone No. 3, 3,550 cu ft of air, 55-F barn and 27-F outside temperatures, the permissible heat losses would be 0.066 Btu per cubic foot and 0.305 Btu per square foot.

These permissible heat losses per square foot mean that the average heat transmission for all exposed parts of the structure, such as walls, windows, etc., must not exceed the figures given, if the desired barn temperature and amount of ventilation is to be maintained. At such times when the outside temperatures fall below the daily mean assumed, the amount of ventilation must be restricted to maintain the thermal balance.

Summary

The following table is a summary of the data required in the design of a cow-barn ventilating system, based on a unit of one cow, 3,000 Btu per hour heat available, 600 cu ft of barn air space, and 130 sq ft of building exposure:

Zone	Temperature Degrees Fahrenheit		Per Cow Per Hour		
	Daily Mean Jan., Feb.	Barn	Ventilation Cu. Ft.	Permissible Heat Losses per 1 Degree Difference	
				Per Cu Ft	Per Sq Ft of Exposure
1	5	45	2600	0.043	0.197
2	17	50	3175	0.051	0.235
3	27	55	3550	0.066	0.305

For barns having a greater volume of space per cow than the 600 cu ft assumed, the permissible heat losses per 1 deg difference per square foot of building exposure must be reduced, while for barns with smaller volumes per cow this loss may be higher. In either case, however, the heat loss per hour per 1 deg difference per cow, must not exceed approximately 26 Btu (130 sq ft × 0.197) for Zone No. 1, 30 Btu for Zone No. 2, and 40 Btu for Zone No. 3.

Acknowledgement

The author wishes to express appreciation to M. A. R. Kelley, Agricultural Engineer, United States Department of Agriculture, and to W. B. Clarkson, Chairman of the Committee on Farm Building Ventilation, *American Society of Agricultural Engineers*, for their constructive suggestions.

Bibliography

1. *Ventilation for Dwellings, Rural Schools and Stables*, by F. H. King (1908).
2. *Some Fundamentals of Stable Ventilation*, by H. P. Armsby and M. Kriss (1921).
3. *Technical Bulletin* 187, U. S. Department of Agriculture (1930).
4. *The Animal as a Convertor of Matter and Energy*, by H. P. Armsby and C. H. Moulton (1925).
5. *Physiology for Medical Students and Physicians*, by W. H. Howell (1906).
6. A Temperature Control Index in Dairy Stable Standardization, by J. L. Strahan (*Agricultural Engineering*, Oct., 1932).
7. *Dairy Stable Ventilation*, by F. L. Fairbanks (A. S. H. V. E. Transactions, Vol. 34, 1928.)
8. *Bulletin*, 151, Cornell University (1926).
9. *Bulletin* 110, New York State College of Agriculture.
10. *Individual Difference in Dairy Cows*, by W. J. Fraser (1901).
11. Why Ventilate Farm Buildings and How (*Heating and Ventilating Magazine*, March, 1923).
12. *Bulletins* 100, 101 and 102, Michigan State College (1929).
13. *Bulletin* 326, Ontario Agricultural College (1927).
14. *Transactions, American Society Agricultural Engineers.*
15. *The Cow*, by Jared Van Wagenen, Jr. (1922).
16. *Bulletin* 98, University of Minnesota (1927).

NOMINATIONS FOR 1933

The Nominating Committee appointed to select candidates for Officers of the Society for the coming year, 1933, submits the following list of nominees:

For President:

W. T. JONES, Boston, Mass.

For First Vice-President:

C. V. HAYNES, Philadelphia, Pa.

For Second Vice-President:

JOHN HOWATT, Chicago, Ill.

For Treasurer:

D. S. BOYDEN, Boston, Mass.

For Members of the Council:

Three-Year Term

R. H. CARPENTER, New York, N. Y.
J. D. CASSELL, Philadelphia, Pa.
F. C. MCINTOSH, Pittsburgh, Pa.
L. WALTER MOON, St. Louis, Mo.

Respectfully submitted,

NOMINATING COMMITTEE

H. M. HART, *Chairman*

Chapters	*Representative*
Cleveland	C. F. EVELETH
Illinois	H. M. HART
Kansas City	B. NATKIN
Massachusetts	C. P. YAGLOU
Michigan	W. G. BOALES
Western Michigan	S. H. DOWNS
Minnesota	C. E. LEWIS
New York	H. M. WYLIE
Western New York	JOSEPH DAVIS
Ontario	W. G. SHEPPARD
Pacific Northwest	——
Philadelphia	W. ROY EICHBERG
Pittsburgh	F. C. MCINTOSH
St. Louis	C. A. PICKETT
Southern California	L. H. POLDERMAN
Wisconsin	J. G. SHODRON

In accordance with the provisions of the Amended Constitution, as given, ballots containing the names of the above candidates will soon be sent to the membership for voting upon prior to the Annual Meeting in January.

Art. 9—*Section* 2. The Nominating Committee shall consist of a member designated by each Chapter, which shall effect its own organization and elect its own Chairman.

Section 3. The Committee may meet at the call of the Chairman, for discussion, but the official meeting shall be held at the Semi-Annual Meeting of the Society, at which time the candidates for each of the offices of the Society to be filled at the next Annual Meeting shall be selected by a majority vote of the members of the Committee present and voting. Five shall constitute a quorum.

Section 4. The Committee shall first secure the consent of all candidates selected, and shall, if possible, announce the names of the candidates at the Semi-Annual Meeting, but in any case the names of the candidates shall be certified to the Secretary of the Society at least four months before the next Annual Meeting. The Secretary shall publish these names in the October issue of THE JOURNAL.

Art. 10.—*Section* 3. The Secretary shall prepare ballots with the names of all candidates and forward them to the members at least thirty (30) days before the date of the Annual Meeting.

Nominations for Members of Committee on Research

Although committees of the Society are usually appointed, in view of the great importance of the Committee on Research and the financial responsibility it would be called upon to assume, it has been made more representative of the entire membership of the Society by a process of *election*. The election is governed by the By-Laws for the election of officers, with the single exception, that Members of the Committee on Research are nominated by the Council instead of by a Nominating Committee.

In accordance with the Regulations for the Government of the Research Laboratory, adopted at the January, 1919, Meeting, and revised January, 1930, the Council announces the nomination of the following members of the Committee for election to succeed those members whose present terms expire January, 1933:

3 Year Term

ALBERT BUENGER, St. Paul, Minn.
S. H. DOWNS, Kalamazoo, Mich.
H. N. KITCHELL, Cincinnati, Ohio
HOMER R. LINN, Chicago, Ill.
PERRY WEST, Newark, N. J.

1 Year Term

E. N. SANBERN, Philadelphia, Pa.

The regulations governing the nomination and election of members of the Committee on Research are as follows:

SECTION I—ORGANIZATION

Research Committee

1. There shall be a standing committee known as the Research Committee, consisting of fifteen members, each serving for three years, and five retiring each year.

a. The Council shall nominate previous to October first of each year five members to fill the vacancies of those retiring at the next Annual Meeting.

b. The nominations made by the Council shall be published in the October issue of the Society's JOURNAL.

c. Prior to December first of any year, any ten members, over their own signatures, may nominate one or more additional members of the Research Committee, and such additional nominations shall be placed on the ballot opposite the nominations made by the Council.

d. The election shall otherwise conform to the regulations provided for the election of officers of the Society.

e. Vacancies may be filled by the Council, such persons chosen by the Council to serve until a successor is elected at the next Annual Meeting.

A. W. Rooks
Reception

E. B. Royer
Registration

I. B. Helburn
Ententainment

H. E. Sproull
Banquet

K. A. Wright, President
Cincinnati Chapter

W. C. Green
General Chairman

G. B. Houliston, Secretary
Cincinnati Chapter

H. N. Kitchell
Vice-Chairman

R. B. Breneman
Ladies'

C. E. Hust
Transportation

J. J. Braun
Publicity

C. J. Kiefer
Finance

Mt. Adams from Eden Park

Ok! Cincinnati!!

EVERYONE in Cincinnati is ready for a delightful meeting of the Society. This will be the 39th Annual Meeting and it will open at the Hotel Gibson, January 23. The Cincinnati Chapter will be host and General Chairman W. C. Green and his assistants on the Committee of Arrangements are introduced at this time to A. S. H. V. E. members.

The Council and various committees of the Society have scheduled meetings in advance of the technical sessions which will be opened on Monday, January 23, by Pres. F. B. Rowley, Minneapolis. Five technical sessions have been arranged and all of them will be held on the Roof Garden of the Hotel Gibson. Extra time for discussion of the Report of the Committee on Revision of the Constitution and By-Laws has been provided on Monday evening.

The technical papers have been contributed from a variety of sources and several have resulted from research work at the Society's Laboratory in Pittsburgh and from cooperating institutions. A series of papers reporting results of air conditioning studies in residences are of special significance. Additional work on oil burner performance and heating boilers brings forth some important data. Studies of condensate and air flow in heating systems have produced data of practical value to designers.

While the technical papers are of unusual variety, entertainment features have not been neglected and the local committee has prepared a program that it believes will be attractive. The ladies will receive particular attention and they will be entertained at luncheon and bridge, a theatre party, a sightseeing trip and a bridge and tea.

To start things off, a Mystery Party will be held on Monday evening for members and ladies and the committee wants to know, "Haf You Effer Been in Zinzinnati?" If not, it would be well to attend and get a glimpse of Old Cincinnati.

The Annual Banquet and Dance has been planned for Tuesday night on the Roof of the Hotel Gibson and an entertaining program has been arranged. A $5.00 charge will be made to members who attend both functions, but they may attend either by paying a proportionate charge. Tickets will be available at the Registration Headquarters which open on Monday morning, January 23. Badges, programs and reprints of papers will be supplied to members and guests.

So that a permanent record may be had of important discussions, members are requested to submit their remarks in writing at each session.

Every effort has been made to meet present day conditions and members will find that hotel room rates are moderate, that reduced fares have been obtained for them and that the charges for entertainment functions are lower than usual.

Members will receive through the mail a booklet on Cincinnati, hotel reservation cards, which should be returned promptly, and an Identification Certificate, which will permit the purchase of round-trip tickets at a rate of fare and a half.

The accompanying program will show the Schedule of Events for the 39th Annual Meeting. Plan to spend the three days, January 23-25, in Cincinnati, the Queen City.

University of Cincinnati

PROGRAM

39th Annual Meeting, American Society of Heating and Ventilating Engineers, Hotel Gibson, Cincinnati, January 23-25, 1933

Sunday, January 22

10:00 a. m. Meeting of the Council (Gold & Ivory Room)

2:00 p. m. Meeting of Committee on Research (Adams Room)

Monday, January 23
(Roof Garden)

9:30 a. m. Greetings—K. A. Wright, President Cincinnati Chapter
Response by Pres. F. B. Rowley
Reports of Officers
Report of Council
Reports of Committees—Finance, Membership, Publication
TECHNICAL PAPERS
Study of the Application of Thermocouples to the Measurement of Wall Surface Temperatures by A. P. Kratz and E. L. Broderick
Some Observations on Heating Practice by James Govan
Report of Committee on Research—Prof. G. L. Larson
Report of Tellers

12:30 p. m. Ladies' Luncheon—Bird of Paradise Room, Hotel Gibson

2:00 p. m. Bridge Tea for Ladies—Golden Palm Room, Hotel Gibson

2:00 p. m. TECHNICAL PAPER
Air Supply and Its Effect on Performance of Oil Burners and Heating Boilers by L. E. Seeley, J. H. Powers and E. J. Tavanlar
Report of Committee on Revision of Constitution and By-Laws by W. T. Jones

6:30 p. m. Dinner for Past Presidents (Gold and Ivory Room)

7:30 p. m. Discussion of Report of Committee on Revision of Constitution and By-Laws (Club Room—10th Floor)

8:30 p. m. A Night in Old Cincinnati (Entertainment, Dance and Buffet Supper)—Roof Garden, Hotel Gibson

Tuesday, January 24
(Roof Garden)

9:00 a. m. Meeting of the Nominating Committee (Gold and Ivory Room)

9:30 a. m. Report of Guide Publication Committee—D. S. Boyden
TECHNICAL PAPERS
Effect of Cold Walls on the Desired Effective Temperature for Comfort by F. C. Houghten
Summer Air Conditioning with Heat Energy—A Report on a Series of Field Tests by E. D. Milener
Study of Summer Cooling in the Research Residence at the University of Illinois by A. P. Kratz and S. Konzo
Summer Cooling Operating Results in a Detroit Residence by J. H. Walker and G. B. Helmrich

10:00 a. m. Ladies See Cincinnati—Taft Museum and Rookwood Pottery

12:30 p. m. Ladies' Luncheon—Florentine Room, Hotel Gibson

2:00 p. m. Ladies' Theatre Party

2:00 p. m. Report of Committee on Chapter Relations—E. K. Campbell
TECHNICAL PAPERS
Corrosion in Air Conditioning Equipment and Its Prevention by R. M. Palmer
Air Supply, Distribution and Exhaust Systems by S. R. Lewis
Cow-Barn Ventilation by A. J. Offner
Air Infiltration through Steel Framed Windows by D. O. Rusk, V. H. Cherry and L. Boelter

7:00 p. m. Annual Banquet and Dance—Roof Garden, Hotel Gibson

Wednesday, January 25
(Roof Garden)

9:30 a. m. TECHNICAL PAPERS
Flow of Condensate and Air in Steam Heating Returns by F. C. Houghten and Carl Gutberlet
Condensate and Air Return in Steam Heating Systems by F. C. Houghten and J. L. Blackshaw
Installation of Officers
New Business
Resolutions

12:30 p. m. Luncheon Meeting—Council

Method of Choosing Location of, Financing and Conducting Meetings of the Society

Resolved: That inasmuch as the Annual and Semi-Annual Meetings of the Society come under the jurisdiction of the Council, the following rules governing the handling of such meetings be adopted by the Council and published in the JOURNAL of the Society at least twice during every year, preferably just prior to each meeting:

1—The Council will select the city in which the Annual or Semi-Annual Meeting is to be held, giving due consideration to the invitations received from Chapters or members as well as to the advisability of so distributing those meetings as to make them of the greatest advantage to the general membership, and to reduce as far as possible the expense of members attending.

2—That an appropriation be made to cover the entertainment or local expenses, incurred in connection with the meeting not exceeding $500.00, the regular meeting expense to be taken care of by the General Fund of the Society in the regular way.

3—That no registration fee or compulsory obligations of any nature be imposed on members or guests.

4—That the purchase of tickets for banquets or for any other form of entertainment that may be provided be entirely voluntary.

5—That the grouping of features and the same of tickets for group features be discouraged.

6—That the raising of Funds from manufacturers of heating apparatus be discouraged.

7—That the display of samples, or of literature, advertising the product of any manufacturer in any way, shape or form, be not permitted at the booths, registration desk, or in or about the meetings.

8—That the distribution of trade papers be entirely at the discretion of the committee in charge.

9—That the local Chapter, or local members, be empowered to form a General Committee with such sub-committees as may be required to handle the details of transportation, hotel accommodations, entertainment, finance, etc., and that this General Committee be requested to confer frequently with the Council, through the Secretary of the Society, and to make frequent reports on progress in connection with the various matters being handled by them.

10—That the arrangements of elaborate and costly entertainment features be discouraged.

Adopted at Council Meeting, January 29, 1926.

Local Chapter Reports

Cleveland

November 16, 1932. In the chapter rooms at the *Cleveland Engineering Society*, 33 members and guests of the Cleveland Chapter were called to order by Pres. R. G. Davis.

After the reading of the minutes, it was reported that the Board of Governors had appropriated $25.00 for the Unemployed Relief Fund and H. M. Nobis stated that the Unemploymem Farm activities were to be continued after the coming winter.

The members and guests present introduced themselves by rising and giving their names.

W. E. Stark reported that the membership dues were to be reduced and that the Membership Committee would start their activities immediately a.ter this action had been ratified by the Council.

President Davis then appointed C. F. Eveleth as representative and F. A. Kitchen as alternate from the Cleveland Chapter on the Nominating Committee.

The chairman of the Program Committee, J. C. Miles, introduced R. G. Olson, who gave a talk on a recent paper by S. R. Lewis, entitled, Air Supply Distribution and Exhaust Systems. Mr. Olson illustrated his discussion by large scale drawings and presented the author's views as well as his own comments in a very interesting and instructive manner.

After a short discussion by various members, Mr. Miles presented F. C. Lyons, Dayton, O., who spoke on Engineering and Sales Methods in the field of air conditioning and cooling.

Mr. Eveleth proposed a rising vote of thanks to both Mr. Olson and Mr. Lyons and the meeting was adjourned at 10:30 p. m.

Illinois

November 14, 1932. A very fine meeting of the Illinois Chapter was held at the Hotel Sherman, Chicago, on November 14, when the speakers were W. L. Fleisher, Consulting Engineer, of New York City, and W. I. Hooper, of the *Illinois Society of Architects.*

Dinner was served at 6:30 p. m. with 41 present, the attendance later being increased to 53.

Chairman R. E. Hattis of the Membership Committee reported the usual fall activities to assure well attended meetings and H. M. Hart mentioned the committee appointed on the code for schoolhouse ventilation and suggested that those interested keep in touch with him.

R. B. Hayward was called upon to introduce the first speaker, Mr. Hooper, who gave a brief address on The Architect's Viewpoint on Ventilation. Mr. Hooper proposed a closer cooperation between the architect and the heating and ventilating engineer in an endeavor to convince the public of the importance of ventilation as an integral part of building operations. He mentioned the fact that ventilation made up only a relatively small percentage of the total building cost and gave figures on five theatre buildings demonstrating this fact. In no case did the ventilating cost exceed 6% and Mr. Hooper advocated that the architect coordinate his work with the heating and ventilating engineer at an early stage of the plans.

Considerable discussion followed Mr. Hooper's talk with comments by H. M. Hart, R. E. Hattis, John Howatt and J. J. Aeberly. Mr. Aeberly, chairman of the Better Relations Committee, suggested to Mr. Hooper that a future meeting with his group be held to discuss closer cooperation.

W. L. Fleisher was then introduced by Mr. Hart and spoke on Cooling by Means of a Steam Ejector System. The Illinois Chapter was particularly fortunate in having an engineer of such prominence and experience discuss this interesting subject.

Mr. Fleisher traced the development of the vacuum refrigeration system from the early machines built about 1900, which employed the steam driven vacuum pump, and the Westinghouse-Le Blanc system developed about 1904 to the modern steam ejector system of today. He followed with a description of the ejector system and the thermodynamic principles involved, giving considerable data on steam and condensing water requirements for specified tonnages. Mr. Fleisher summarized the important features of the ejector system as follows: relatively low first cost; water refrigerated directly; absence of ammonia or other toxic gases; system under vacuum; few moving parts with the exception of two pumps; and the fact that steam for residence cooling in summer about equals steam required for heating in winter.

A lengthy discussion followed Mr. Fleisher's talk and among those taking part were Messrs. Aeberly, Howatt, Hattis and Hart.

Kansas City

November 14, 1932. An interesting meeting of the Kansas City Chapter was held at the Newbern Hotel, at 6:30 p. m., and was presided over by Vice-Pres. David Caleb in the absence of Pres. W. A. Russell.

The routine business included a report by Carl Clegg, chairman of the Membership Committee, and a discussion of Limited Chapter Membership.

A joint meeting of the Chapter with the local group of the *American Society of Mechanical Engineers* was talked of and it was planned to hold this meeting in Thomas Edison Hall in the new Kansas City Power and Light Bldg. It was expected that the National President of the *A. S. M. E.* would be a speaker and E. K. Campbell assumed the responsibility of arranging for a suitable speaker to represent the A. S. H. V. E.

Prof. A. H. Sluss mentioned that a convention of the Master Plumbers of Kansas was to be held shortly and hoped that it would be possible for the Chapter to cooperate with them and furnish technical discussion for their meeting. It was decided to obtain further information regarding meeting place, etc.

The feature of the evening was a paper on School House Ventilation by A. J. Nesbitt, Philadelphia, Pa. Mr. Nesbitt's presentation was very interesting and drew an animated discussion from the members present.

The regular educational feature was a paper presented by H. C. Henrici on the Future of Air Conditioning.

Massachusetts

November 28, 1932. At a luncheon meeting of the Massachusetts Chapter, 30 members met at Durgin Park & Co.'s banquet room, Boston, and Pres. F. R. Ellis called upon W. T. Jones, who asked for the cooperation of chapter members during the coming year.

Alfred Kellogg was then introduced by President Ellis and spoke about the valuable services rendered by the *Affiliated Technical Societies of Boston* and the members present also discussed the subject of licensing engineers. The matter was left with the Board of Governors to consider and report at the next chapter meeting.

At the conclusion of the business meeting, John W. Pierce, Director of the Engineering Bureau of the Emergency Planning and Research Bureau, outlined in an interesting manner the work undertaken, whereupon the entire meeting adjourned to the Bureau Rooms for inspection of some of the results obtained. The Bureau has a splendid record of operation and accomplishment, allowing deserving and unemployed engineers to work for a modest fee while formulating valuable data on many

fields of activity. It reflects great credit to the *Engineering Societies of Boston* through their various committees of the Emergency Planning and Research Bureau and allows the contributing members of the engineering profession to point with pride to a project well conceived and executed.

Michigan

November 14, 1932. A dinner meeting of the Michigan Chapter held in the Detroit Leland Hotel brought an attendance of 50 members and guests when Pres. L. L. McConachie requested roll call.

J. F. McIntire gave a report of the Council meeting held at Milwaukee during the Semi-Annual Meeting of the Society, at which time the matter of dues was discussed, and this was commented on by W. A. Rowe.

The Chapter was pleased with the report of the Membership Committee which showed 6 new members.

A discussion of Temperature Regulation followed and was taken part in by L. H. Kintz, F. C. Purcell, A. C. Grant, E. B. Root, R. D. Randall and E. H. Clark.

Sufficient interest developed to hold the meeting open until 10:30.

Minnesota

November 8, 1932. The regular November meeting of the Minnesota Chapter was dispensed with in favor of the Annual Fall Party, when the ladies are guests of the Chapter. This year the usual formal dinner dance gave way to a very informal Election Night Party at which 40 members and their wives were present. A very excellent orchestra provided music, complete election returns were received by radio and food and refreshments were continuously available.

It is needless to say that the above combination produced a royal good time for all.

New York

November 21, 1932. Following the Special Meeting of the A. S. H. V. E. held in the Building Trades Club, New York City, at 5:30 p. m., the New York Chapter held a dinner and meeting with an attendance of 128 members and guests, of whom many were from out of-town.

W. T. Jones, Boston, 1st Vice President of the A. S. H. V. E., was introduced by Pres. L. T. M. Ralston and he commended the Chapter for the unusually large attendance. Pres. Ralston mentioned that members were present from the Massachusetts and Illinois Chapters and that the Chapter was fortunate in having its one lady member, Miss Margaret Ingels, in attendance.

One table was reserved for National Council members and R. H. Carpenter, a member of this group, spoke briefly about the financial condition of the Society and urged payment of dues immediately. He then congratulated the Chapter on its choice of officers and on the splendid work being done by them.

The meeting was in the form of a Symposium on Ventilation with three principal speakers: Dr. Leonard Greenburg, A. J. Nesbitt and W. H. Driscoll.

Dr. Greenburg read an address prepared by Dr. C.-E. A. Winslow on School Room Ventilation in which tribute was paid to the work of the Society's Committee on Ventilation Standards.

A. J. Nesbitt, Philadelphia, presented a paper entitled A Logical Basis for Determining the Volume of Air to Be Circulated for Classroom Ventilation. His data and conclusions were based on extensive experimental work carried on in school rooms. His remarks were illustrated by lantern slides showing charts and tables.

W. H. Driscoll, Chairman of the A. S. H. V. E. Committee on Ventilation Standards, spoke on the code requirements and gave interesting details of the committee's work and its long study before a word of the code was drafted. Mr. Driscoll stated that the committee is open minded and would welcome any suggestions of a scientific nature. He gave an interesting outline of ventilation progress, citing the divergent and ever-changing views of the medical authorities in the past on the amount and quality of air required and remarking that the history of ventilation has been a history of error.

Dr. Greenburg gave a few concluding remarks commending Mr. Nesbitt's paper for its scientific approach to the problem and complimented the work of Mr. Driscoll and the Committee on Ventilation Standards.

Ontario

December 5, 1932. Thirty eight members and guests of the Ontario Chapter assembled in the Grillroom of the Prince George Hotel, where, following a delightful dinner, Pres. J. S. Wood introduced A. J. Nesbitt, Philadelphia, Pa., the principal speaker of the evening.

Mr. Nesbitt gave a very interesting address on Unit Ventilation and related a number of experiments which he had conducted in classroom unit ventilation. He also presented slides, which showed valuable data obtained from the tests he had made. Following Mr. Nesbitt's address, a discussion between various members present and the speaker took place.

M. F. Thomas extended a vote of thanks to Mr. Nesbitt for his splendid talk and expressed the wishes of the Chapter to have him visit Toronto again at a later date.

Pacific Northwest

October 11, 1932. The first meeting of the 1932-33 season was held at the Edmond Meany Hotel with Pres. C. F. Twist presiding.

The Chapter was honored to have as its guest and speaker, Prof. F. B. Rowley, National President, who spoke on some of the proceedings of the Semi-Annual Meeting in Milwaukee last June. His explanation of the Society's Ventilation Standards and reasons for their adoption was of interest and instructive to the members and guests. Following a discussion of the Society's research activities, President Rowley gave a talk on Ventilation for Comfort and Health. The visit of President Rowley was an occasion greatly enjoyed by the Pacific Northwest Chapter.

The meeting which was attended by 40 members and guests was concluded with a discussion by the members of the necessary work required to evolve some legislation for the protection and advancement of professional heating and ventilating engineers.

Philadelphia

November 10, 1932. The regular meeting of the Philadelphia Chapter was held at the Penn Mutual Life Insurance Co. Bldg. and, following dinner in the main dining room, the meeting was called to order by Pres. L. C. Davidson. The minutes of the previous meeting and the report of the treasurer were read and approved.

J. H. Hucker, a member of the committee appointed by President Davidson, read resolutions occasioned by the loss through death of four members of the Philadelphia Chapter during the summer months.

The chairman of the Nominating Committee, E. N. Sanbern, presented a list of the proposed nominees for the following offices to be elected at the January meeting:

President—M. F. Blankin
Vice-President—W. P. Culbert
Secretary—W. R. Eichberg
Treasurer—J. H. Hucker
Board of Governors—L. C. Davidson, W. F. Smith and A. McClintock, Jr.

President Davidson then turned the meeting over to Mr. Eichberg, chairman of the Meetings Committee, who presented Mr. Conover of the Penn Mutual Life Insurance Co. Mr. Conover

welcomed the Chapter as guests in a visit to their new building and also gave a short talk in which he expressed his thanks for the cooperation that had been received from all contractors connected with the erection of the structure.

Ernest Matthewson, architect for the building, was next called upon and read a very interesting paper which gave a general description of the building and told of some of the problems that had been overcome in its construction and the unusual features which it contained.

Short talks were made by Mr. Doyle, the builder, Mr. Anderson, the heating contractor, and Mr. Buchanan, the electrical contractor. Mr. Hutchinson, of I. H. Francis' Office, the consulting engineer, explained the mechanical layout of the building and the equipment that was used.

The meeting then adjourned and the members of the Chapter made a tour of inspection of the building.

Pittsburgh

November 14, 1932. H. Lee Moore, who had been appointed temporary chairman in the absence of Pres. R. B. Stanger, called the 25 members and guests of the Pittsburgh Chapter to order in the Assembly Room of the Fort Pitt Hotel.

The minutes of the October meeting were read and approved and H. B. Orr, treasurer, reported that the funds of the Chapter had been involved in the closing of the Diamond National Bank and appealed to the members to pay their delinquent dues and help meet the emergency.

Mr. Moore, chairman of the Nominating Committee, submitted the following report of his committee as nominations to be voted upon at the December meeting, which is also the annual meeting of the Chapter:

President—G. S. McEllroy
Vice-President—P. A. Edwards
Secretary—J. L. Blackshaw
Treasurer—H. B. Orr
Board of Governors—R. B. Stanger, Peter O'Neill and F. H. Hecht.

The speaker of the evening was W. S. Brotzman, Associate Meteorologist of the U. S. Weather Bureau in charge of the Pittsburgh Office, who was introduced by M. A. Benson. Mr. Brotzman gave an illustrated talk and reviewed the forecasting of weather from the era of the oldtime weather prophet, who really could forecast as much as 12 hours in advance of the weather, to 1932 with its modern and efficient service which the present Weather Bureau offers. Mr. Brotzman described the construction and use of equipment operated by the bureau, including thermographs, psychrometers, sunshine recorders, triple registers and telegraphic equipment. He also explained the making and interpretation of weather maps and told much of interest concerning weather phenomena near Pittsburgh.

After an exceedingly full and interesting discussion, Mr. Brotzman was given a rising vote of thanks in appreciation of his talk.

St. Louis

December 7, 1932. The December meeting of the St. Louis Chapter was preceded by a dinner and was held at the Roosevelt Hotel.

Pres. J. M. Foster called the gathering to order and the minutes of the previous meeting were read and approved. Due to the absence of A. L. Walters, treasurer, the secretary presented the financial statement for the year 1932.

President Foster appointed Mr. Pickett as representative and Mr. Davis as alternate to serve on the National Nominating Committee.

Secretary Davis then read a letter from the members of the Nominating Committee, presenting the following slate:

President—C. A. Pickett
1st Vice-President—Paul Sodemann
2nd Vice-President—J. W. Cooper
Secretary—C. R. Davis
Treasurer—A. L. Walters
Board of Governors—J. M. Foster, G. W. F. Myers, E. A. White and E. E. Carlson.

As no nominations were made from the floor, the members present voted and unanimously elected the slate submitted by the Nominating Committee.

The meeting was placed in the charge of Mr. Sodemann, chairman of the Entertainment Committee, who introduced E. A. Freund, who addressed the chapter on the subject of The Air Conditioning Industry. It was evident that Mr. Freund had spent considerable time and energy in the preparation of this paper and slides and his talk was well received by the 33 members and guests present.

Considerable discussion took place, after which Mr. Sodemann turned the meeting back to President Foster, who made his farewell address to the chapter and thanked the officers and members of the various committees who had served during the past year.

Mr. Foster then gave the chair to President Pickett who asked the cooperation of the entire chapter in continuing to work for its benefit.

November 16, 1932. Following dinner at the Roosevelt Hotel the St. Louis Chapter meeting was called to order by Pres. J. M. Foster and the minutes of the previous meeting were read and approved.

Reports of the various committee chairmen were received and in reporting as Employment Officer, E. A. White requested that the Chapter donate $100.00 towards a fund sponsored by the Joint Engineering Council for the relief of engineers in destitute circumstances, which money was to be used as a loan and paid back at a later time. P. W. Sodemann, as acting secretary, gave a brief resumé of the present financial condition of the Chapter and the matter was also commented on by C. A. Pickett. A motion was made by A. L. Walters and seconded by Mr. Pickett that no contribution could be made at this time, as the financial condition of the Chapter would not permit.

J. W. Cooper reported for the Nominating Committee and stated that candidates had been selected for election at the December meeting.

The meeting was then turned over to Mr. Sodemann, chairman of the Program Committee, who introduced A. J. Nesbitt, Philadelphia, Pa.

Mr. Nesbitt gave a very interesting and informative talk on A Logical Basis for Determining the Volume of Air to be Circulated in Classroom Ventilation, which was supplemented by slides. Mr. Nesbitt's data showed that most often the problem involved in classroom ventilation was a matter of cooling rather than heating. After his talk, considerable discussion occurred regarding the various phases of the work.

Southern California

November 22, 1932. The November meeting of the Southern California Chapter was held at the Nikabob Cafe with Pres. F. R. Winch presiding and at this time the last business of the fiscal year was transacted with the final report of all Chapter committees.

A resolution which had been passed by the Board of Governors and forwarded to the Headquarters Office was read by the secretary.

The members discussed ways of obtaining a more thorough and wider interest in the Society and a committee was appointed to formulate such a plan. It was also decided to have occasional meetings during the lunch hour in an effort to increase the attendance.

The election of officers was held with the following result:

President—L. H. Polderman
Vice-President—W. H. C. Ness
Secretary—E. H. Kendall
Treasurer—Leo Hungerford

Board of Governors—F. R. Winch, J. M. LaMontagne and H. L. Warren.

The chair then turned the meeting over to M. M. Lawler, one of the Chapter's most active members, who presented a talk with slides on the Various Phases of the Psychrometric Chart. This precipitated a very lively discussion among those present of the subject and included the various kinds of air conditioning equipment now in use.

Western Michigan

November 14, 1932. After dinner in the English Room of the Rowe Hotel, Grand Rapids, Pres. D. L. Taze opened the meeting of the Western Michigan Chapter at which the attendance was 35 members and guests. Committee reports indicated that the administrative machinery of the Chapter was functioning well and that the general interest and stability was on the increase.

S. S. Sanford, Detroit, was good enough to appear before the Chapter again this year and present his paper, Field Studies of Office Building Cooling. With the aid of stereopticon slides showing instrument set-ups and characteristic curves of various results obtained, he presented the facts collected from extensive observations of the cooling characteristics of the air conditioning system in a large Detroit office building, together with its physiological results on occupants, the effects of exterior conditions of solar radiation, atmospheric temperature, humidity, etc. It was very interesting to note that all observations pointed to the fact that solar radiation was by far the greatest load that the cooling system has to contend with. Taken from a practical and commercially successful installation, the data was exceedingly valuable and presented by Mr. Sanford, who has the ability of making his explanations thorough, it made a very interesting lecture that prompted a lengthy open discussion.

Western New York

November 14, 1932. The Western New York Chapter's second meeting of the season, which was held at Gandy's, showed a marked improvement in attendance with 40 members and guests present and the resultant enthusiasm promised great success for the coming meetings.

Roswell Farnham again spoke on the question of dues to the National Society and urged all delinquent members to do what they could at this time.

The treasurer of the Chapter, Walter Johnson, urged local support and asked the members to contribute their Chapter dues.

Pres. M. C. Beman was named as representative and D. J. Mahoney, 1st Vice-Pres., as alternate to serve on the Society's Nominating Committee at the Annual Meeting in Cincinnati, January 23-25.

Plans for the Xmas Party were discussed and Mr. Mahoney and W. E. Voisinet, secretary, were appointed to assist the Entertainment Committee in preparing for this mid-year social gathering.

At the request of President Beman, Ralph T. Coe, of Rochester, very fittingly introduced the speaker of the evening, E. L. Anderson, Detroit, who spoke on Sound Prevention in Heating and Ventilating work. Mr. Anderson first covered the fundamental physics of sound and noise and then clearly explained many of the causes of noises in the industrial field and corrective measures used to overcome them. Actual demonstrations with recording instruments made his talk exceedingly interesting and the lively discussion following Mr. Anderson's talk gave evidence that this technical program was a complete success.

Wisconsin

October 17, 1932. The October meeting of the Wisconsin Chapter was called to order by Pres. V. A. Berghoefer and the minutes of the previous meeting were read and approved.

An enthusiastic report on the Joint Chapter Meeting held at Urbana, Ill., was given by E. A. Jones, who also told of the research work being carried on at the University of Illinois.

Ernest Szekely outlined the plans of the Program Committee for the coming year, the committee consisting of Mr. Szekely as chairman, J. H. Volk, J. S. Jung, President Berghoefer and C. H. Randolph, Secretary.

President Berghoefer introduced the guests of the Chapter, Messrs. Kampman and Oakwood, and then presented the speaker of the evening, Mr. Sloan, whose instructive and interesting talk on Refrigerating Machinery, was accompanied by slides. It was an enjoyable evening for the Wisconsin members who are vitally interested in air conditioning in which refrigeration holds a prominent place. The interest in Mr. Sloan's address was evidenced by the questions asked which took over half an hour's time.

A short business session was held and the meeting was adjourned.

September 26, 1932. Eighteen members and guests of the Wisconsin Chapter met at the Ogden Café on Monday evening and Pres. E. A. Jones opened the business meeting at 7:45 p. m. He announced that the election ballots had been received and named A. M. Wagner and F. G. Weimer as tellers, instructing them to proceed at once with the counting.

President Jones then read letters from the national president, F. B. Rowley, and secretary, A. V. Hutchinson, in commendation of the Semi-Annual Meeting held in Milwaukee in June. President Jones personally paid tribute to J. S. Jung and his committee chairmen for their splendid execution of meeting arrangements.

Prof. G. L. Larson was asked to tell of the proposed Joint Chapter Meeting at the University of Illinois, Urbana, Ill., and he responded by announcing the purpose of the gathering and the program which had been arranged.

M. E. Erickson submitted the report of the treasurer which was accepted.

The tellers then reported that their ballot tabulations had been completed and President Jones announced the results:

President—V. A. Berghoefer
1st Vice-President—J. S. Jung
2nd Vice-President—Ernest Szekely
Secretary—C. H. Randolph
Assistant Secretary—A. F. Bowers
Treasurer—M. E. Erickson
Board of Governors—G. L. Larson, J. G. Shodron and E. A. Jones.

Mr. Jones then turned the chair over to the newly elected president, Mr. Berghoefer, who expressed his deep gratitude for the privilege and honor and suggested a rising vote of thanks for the retiring president, Mr. Jones, which was given enthusiastically.

President Berghoefer then introduced the speaker of the evening, Mils Laboritsch, local Assistant Meteorologist, who spoke on the How and Why of Wisconsin Weather Conditions, which proved to be a very interesting and instructive subject.

A new Chapter member, George Hockstein, was presented and Professor Larson introduced J. W. James of the University of Wisconsin.

After some discussion relative to Limited Chapter Membership it was moved and carried that this plan be extended one year, if after the completion of the first year, it was deemed advisable.

Professor Larson spoke of the vital necessity of meeting the National Society dues and mentioned that Wisconsin was in a favorable condition in this respect. He also said that in his travels since the Semi-Annual Meeting he had heard some excellent reports regarding the meeting and the Chapter could feel justly proud of the work that had been done and of the success of the meeting, which was due largely to the zealous efforts of Mr. Jones and the Committee on Arrangements.

In closing, President Berghoefer made a plea for new members and the meeting adjourned.

Fan Code Presented at A. S. M. E. Annual Meeting

The 53rd Annual Meeting of the *American Society of Mechanical Engineers* was held December 5 to 9, 1932, at the Engineering Societies Building, New York. Of particular interest to A. S. H. V. E. members was a session devoted to a public hearing on the Proposed A. S. M. E. Code for Centrifugal Compressors, Exhausters and Fans. The A. S. H. V. E. was invited to cooperate with the *A. S. M. E.* at this session. The presiding officer was Prof. R. H. Fernald, Dean of the Towne Scientific School, University of Pennsylvania, Philadelphia.

The presentation of the Test Code was preceded by two papers, namely, Influence of Bends in Inlet Ducts on the Performance of Induced-Draft Fans, by L. S. Marks, J. Lomax and R. Ashton, and Pulsation of Air Flow from Fans and Its Effect on Test Procedure, by Harold F. Hagen.

The paper on Influence of Bends indicated the loss in capacity and efficiency of a fan that resulted from the location of elbows or bends close to the inlet boxes. The loss was shown to be a function of the type of bend, of its *aspect ratio* or ratio of depth to width, and of the direction in which the air is turned in the bend. It was indicated that by the use of guide vanes in the bend the loss can be almost entirely prevented. When scroll inlet boxes provided with guide vanes are used, this loss does not occur, but the capacity with such boxes is low, although the efficiency is maintained. The cause of the loss is not the friction in the bend, but is the poor distribution of the air leaving the bend and entering the inlet box. The use of a short length of straight duct between the bend and the inlet box will reduce the loss appreciably. Measurements by Pitot tube of the distribution of velocity and static pressures at the entrance to the inlet boxes indicated the existence of this loss and the desirability of inserting guide vanes in the bends.

The paper on Pulsation of Air Flow, by Mr. Hagen, showed experimentally that an error results from velocity-pressure demonstrations of volume when a pulsating velocity exists. The paper contained quantitative data on the amount of error and suggested changes in fan testing procedure.

After the presentation of the papers, Professor Fernald took up the Test Code which was a part of the *A. S. M. E.* Power Test Codes Series 1932, and was divided into two parts, namely, Part I, Compressors and Exhausters, and Part II, Fans. The personnel of Power Test Codes Individual Committee No. 10 consisted of A. T. Brown, *Chairman*, W. H. Carrier, L. E. Day, E. S. Dean, Z. G. Deutsch, P. E. Good, H. F. Hagen, H. D. Kelsey, Arvid Peterson and M. C. Stuart.

Considerable written comment had been received on the Fan Section and after some discussion it was moved that consideration of this section be deferred and that a joint committee of the *American Society of Mechanical Engineers* and the American Society of Heating and Ventilating Engineers be appointed to draft a code which would be acceptable to both organizations.

The code submitted differs considerably from that adopted by the Society in 1923 jointly with the *National Fan Manufacturers Association*. The Society was represented at this meeting by a committee consisting of Dean F. Paul Anderson, W. A. Brown, A. C. Davis, H. H. Marshall, Pierce Timmis and R. A. Wolff. With Dean Anderson and Mr. Davis acting as spokesmen, valuable testimony was presented with respect to the accuracy of the present A. S. H. V. E. Code. Mr. Davis stated that he had used the code with satisfactory results during the ten years it has been in existence.

The Annual Power Show was held at Grand Central Palace from December 5 to 10, inclusive, in conjunction with the *A. S. M. E.* Meetings. The show was unusually well attended and included many outstanding exhibits of materials and apparatus relating to power and mechanical engineering. Many displays of heating, ventilating and air conditioning equipment were shown.

Kroeschell Engrg. Co. Organized

Announcement has been made of the formation of the Kroeschell Engineering Co., a contracting and engineering organization equipped to handle all kinds of air conditioning and refrigeration, with offices at 2306 N. Knox Ave., Chicago, Ill. The personnel includes Arnold H. Goelz, president and treasurer; Robert A. Kroeschell, vice-president; Paul H. Kroeschell, secretary, and O. W. Armspach, Harry M. Coesfeld, Frank Felbinger, William Martens and Hans A. Stade.

Death of August Kehm

In the death of August Kehm on Sunday, December 11, 1932, the heating profession loses a wellknown and beloved member and the American Society of Heating and Ventilating Engineers, which he joined in 1901, will miss an active and loyal supporter. Mr. Kehm served the Society as First Vice-President in 1909 and was on the Board of Governors from 1908-1911. He was selected as the first treasurer of the Illinois Chapter, an office which he held for 24 years, and his interest in local as well as national affairs was unfailing. He was very active in the *Chicago Association of Master Steamfitters* and was a member of the *Heating and Piping Contractors National Association*, the Chicago Engineers Club, *Western Society of Engineers*, Hamilton Club and the Lake Shore Athletic Club. His friends were legion and his readiness to share his knowledge and lend a helping hand to his fellowman is legendary in Chicago.

Mr. Kehm was born in Chicago, Ill., on October 23, 1868, and his experience in the contracting field dates from 1882 when he served as apprentice steamfitter and machinist with F. W. Lamb & Co. From 1894 he was a member of Kehm Brothers Co. and at the time of his death he was president of the firm, which has been responsible for the installations in many important buildings in Chicago and the vicinity.

At the December 12 meeting of the Illinois Chapter a moment of silent tribute was paid to him and the Chapter was represented at the funeral services which were held on Tuesday, December 13, at Jordan's Chapel.

Mr. Kehm is survived by his widow and one son, Horace S. Kehm, to whom the Officers and Council extend their sincere sympathy for the loss which they have sustained.

British Engineers Program

Meetings scheduled for 1932-33 by the *Institution of Heating and Ventilating Engineers* are listed by Secretary H. B. Watt and for the Associate Members and Graduates Section, London District and Manchester District Branches by J. H. Bryant and W. S. Holt, respectively.

The program included an Autumn Special Meeting held in October, at which H. M. Vernon spoke on the subject of The Measurement, in Relation to Human Comfort, of the Radiation Produced by Various Heating Systems, and Sessional Meetings in November and December when A. F. Dufton spoke on Radiant Heat and Oscar Faber discussed Examples of Modern Heating, Ventilating and Electrical Installations. The schedule for January, March and April includes the following speakers: C. A. Cameron Brown, Soil Heating by Electricity; P. Wyllie Kerr, Centrifugal Fans and Their Relation to Air Circuits; Bernard C. Oldham, The Application of Refrigeration to Air Conditioning. In February an Ordinary Meeting is planned at which time Edgar Herring will speak on the Warming and the Ventilation of the Masonic Peace Memorial Building, London, with an introduction by J. Roger Preston. In June a Summer Special Meeting will be held with a paper by I. Lubbock on Gas Flow and Radiation.

The London District Branch, Associate Members and Graduates Section, has arranged many meetings and visits to industrial

plants. Among the subjects to be discussed are: Some Features of the Manufacture of Malleable Iron Fittings and Cast Iron Radiators, C. E. Green; The Practical Side of Ventilation, W. H. Rogers; Notes on Drying, W. H. Dupen; Electric Motors and Starters, E. M. K. Mead; Some Notes on Flow of Air Through Ducts, E. L. Joselin, and Notes on Unit Heating, A. Uvary.

In addition to visits to industrial plants, the Manchester District Branch, Associate Members and Graduates Section, plans the following programs at their monthly meetings: Steam Boilers, W. Atkinson; The Saving of Coal in Industrial Plants, H. Pennington; Snags in Heating and Hot Water Supply Installations, A. Hindley; and Heating and Hot Water Supply in Abattoirs, E. Golightly.

CANDIDATES FOR MEMBERSHIP

The Constitution of the Society as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Membership Committee as soon as possible.

When the Membership Committee has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 12 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Membership Committee, and in turn the Council, urge the members to assume their share of the responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some members by January 14, 1933, these candidates will be balloted upon by the Council. Those **elected to membership will be notified by the Secretary immediately after election.**

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
ARCHDEACON, HOWARD K., Student, New York University, New York, N. Y.	Herbert Maiman Abraham Raffes	G. W. O'Hare R. D. Morrill
DONZELLI, ENRICO, Managing Director, E. Donzelli & C., Milan, Italy.	C. F. Hauss Guido Vitullo—(*Non-Member*)	
FLOYD, MORRIS, Sales Mgr., Air Cond. Div., Edwards Mfg. Co., Cincinnati, O.	E. P. Bailey C. J. Kiefer	K. A. Wright G. B. Houliston
GOULDING, WILLIAM, National Broadcasting Co., New York, N. Y.	P. D. Close W. E. Heibel	Russell Donnelly E. J. Ritchie
HANSON, LESLIE PAUL, Graduate Student, University of Minnesota, Minneapolis, Minn.	F. B. Rowley A. B. Algren	Albert Buenger J. V. Martenis
JAMES, JOHN WILLIAM, Research Fellow, Mech. Engrg. Dept., University of Wisconsin, Madison, Wis.	G. L. Larson D. W. Nelson	C. L. Dean F. G. Weimer
MAY, GEORGE ELMER, Refrig. & Air Cond. Promotion, New Orleans Public Service, Inc., New Orleans, La.	O. E. Gammill, Jr. D. S. Anderson—(*A. I. E. E.*)	D. S. Elliott—(*A. P. S.*) J. M. Todd—(*A. I. E. E.*)
MCLENEGAN, DAVID W., Asst. Engr., Com. Engrg. Div., Air Cond. Dept., General Electric Co., Schenectady, N. Y.	Andrew Vogel P. S. Lyon	Elliott Harrington A. R. Stevenson, Jr.
MYERS, FRANK L., Sales Engr., Owens-Illinois Glass Co., Toledo, O.	J. H. Van Alsburg P. L. Reed	Bert Bernstrom F. W. Berry
OLCHOFF, MAURICE, Olchoff Engrg. Co., Kansas City, Mo.	Carl Clegg W. E. Gillham	C. A. Weiss D. D. Zink
PILLEN, HARRY A., Mfrs. Repr., Harry A. Pillen Co., Cincinnati, O.	G. B. Houliston A. W. Rooks	F. D. Mensing K. A. Wright
RICHARD, EDWIN J., Edwin J. Richard Equipment Co., Cincinnati, O.	G. B. Houliston W. C. Green	C. J. Kiefer K. A. Wright

Candidates Elected

In past issues of the JOURNAL of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Membership Committee and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. II, Sec. VIII, of the By-Laws, the following list of candidates elected:

MEMBERS

ELLIOTT, LOUIS, Cons. Mech. Engr., Electric Bond & Share Co., New York, N. Y.

FAGIN, DANIEL J., Laclede Gas Light Co., St. Louis, Mo.

MITTENDORFF, EDWARD M., Sales Engr., Sarco Co., Inc., Chicago, Ill.